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Scope of High Speed Packet Access (HSPA) Evolution for 1.2 Mcps TDD
(Release 8)

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Contents

Foreword

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y the second digit is incremented for all changes of substance, i.e. technical enhancements, corrections, updates, etc.

z the third digit is incremented when editorial only changes have been incorporated in the document.

1 Scope

The present document has been produced in the scope of the study item on "HSPA Evolution for 1.28Mcps TDD" [2]. The objective of the study item is to develop a framework for the evolution of the 1.28Mcps TDD mode of the 3GPP HSPA TD-SCDMA-based radio-access technology from Release 8 onwards.

This document lists the constraints for the 1.28Mcps TDD HSPA Evolution in Release 8 and an assessment of technical proposals and their respective, achievable performance and complexity.

2 References

The following documents contain provisions which, through reference in this text, constitute provisions of the present document.

- References are either specific (identified by date of publication, edition number, version number, etc.) or non-specific.
- For a specific reference, subsequent revisions do not apply.
- For a non-specific reference, the latest version applies. In the case of a reference to a 3GPP document (including a GSM document), a non-specific reference implicitly refers to the latest version of that document *in the same Release as the present document*.

[1] 3GPP TR 21.905: "Vocabulary for 3GPP Specifications".

[2] 3GPP TD RP-070673: "Work Item Description on Scope of future HSPA Evolution for 1.28Mcps TDD".

3 Definitions, symbols and abbreviations

3.1 Definitions

For the purposes of the present document, the terms and definitions given in TR 21.905 [1] and the following apply. A term defined in the present document takes precedence over the definition of the same term, if any, in TR 21.905 [1].

HSPA: In this document, the acronym **HSPA** (High Speed Packet Access) is used to qualify the 1.28Mcps TDD mode features HSDPA (High Speed Downlink Packet Access) and Enhanced Uplink as defined in the Release 7 version of the 3GPP Specifications.

Backward Compatibility: In this document, **Backward Compatibility** means the ability of an HSPA infrastructure to simultaneously allocate radio resources on a single or multiple carriers to post-release 8 terminals and terminals compliant with previous releases of the 3GPP specifications without performances degradation for either type of terminal. It is understood that in that case the performance enhancements targeted in this document would only apply to post-release 8 terminals and that the full potential of system performance enhancements would only be achievable if all terminals operating simultaneously on a single carrier were post-release 8 terminals.

3.2 Symbols

For the purposes of the present document, the following symbols apply:

Symbol format

<symbol>	<Explanation>

3.3 Abbreviations

For the purposes of the present document, the abbreviations given in TR 21.905 [1] and the following apply. An abbreviation defined in the present document takes precedence over the definition of the same abbreviation, if any, in TR 21.905 [1].

CAPEX	Capital expenditure
CPC	Continuous Packet Connectivity
CS	Circuit Switched
DRX	Discontinuous Reception
HSPA	High Speed Packet Access
LTE:	Long Term Evolution
MIMO	Multiple Input Multiple Output
NAS	Non Access Stratum
OPEX	Operational expenditure
QoS	Quality of Service
PS	Packet Switched
TCP	Transmission Control Protocol
UE	User Equipment

4 Introduction

The Study Item Description on "HSPA Evolution for 1.28Mcps TDD" [2] was approved by the 3GPP TSG RAN #37 plenary meeting in September 2007.

The importance of on-going and future efforts to enhance the capabilities and performance of HSPA-based radio networks is widely recognised and has recently been highlighted. In order to protect the prophase investment of telecommunication operators and offer a smooth migration path towards LTE, the following elements should be considered as guiding principles for HSPA Evolution:

1. HSPA spectrum efficiency, peak data rate, state transition efficiency and latency of both user plane and control plane should continue to evolve.

2. Evolved HSPA should be able to operate as a packet-only network based on utilization of Shared Channels only;

3. HSPA Evolution should be backward compatible in the sense that legacy terminals (R99-DCH and HSPA mobiles) should be able to share the same carrier with terminals implementing the latest features of the HSPA Evolution track without any performance degradation;

4. Evolved HSPA should be able to offer more efficient QoS support.

5 Objectives

The study should focus on improving the system performances for services delivered through the PS-domain including voice and multimedia conversational services. Critical elements of such evolution should include reduced latency, higher user data rates, improved system capacity and coverage and reduced cost for the operator while maintaining the highest possible level of backward compatibility. The Evolved HSPA SI should concentrate on the following items:

a) Define a set of requirements for HSPA evolution which covers the following aspects:
   - o Targets for improvements in latency, throughput and spectrum efficiency utilising the existing 1.28MHz bandwidth;
   - o Define constraints in terms of acceptable hardware and software changes to current elements {UE, Node, RNC, SGSN and GGSN};
   - o Define constraints in terms of acceptable network architecture changes.

b) Determine what performance benefit is achieved by the HSPA and in which scenarios HSPA evolution applies most.

c) Identify potential solutions to improve HSPA performance towards the agreed targets within the e, defined constraints;

d) Make recommendations for future HSPA Evolution WIs.

6 Constraints and Requirements

Note: This chapter will capture text on the constraints for 1.28Mcps TDD HSPA evolution including on legacy issues, backward compatibility, architecture, impact on LTE, Node B and UTRA, software and hardware upgrades, complexity issues, acceptable impacts on UE's, protocol reuse/requirements, signalling and physical channel limitations, etc.

7 Elements of Study

Note: This chapter will contain topics handled during the study item, like architecture and UTRA.

8 Release 7 Technical Performance

Note: This chapter will capture text describing UTRA and UTRAN performance as reachable with techniques specified in Release 7.

9 Technical Proposals and Assessment

Note: This chapter will capture all technical proposals and the assessment of each proposal, achievable performance and complexity.

9.1 Architecture

9.2 Continuous Packet Connectivity

9.2.1 Motivation

The motivation of Continuous Packet Connectivity (CPC) for 1.28Mcps TDD can be summarized as:

- Significantly increase the number of inactive packet data users that can stay in CELL_DCH state over a long time period without degrading cell throughput and that can restart transmission with a much shorter delay than would be necessary if UEs are transferred from another state before data can be transferred;
- Reduce UE power consumption;
- Optimize HSDPA/E-DCH to transport low-latency low data-rate traffic like VoIP more efficiently;

9.2.2 Analysis of HSDPA/E-DCH and the scope of CPC for 1.28Mcps TDD

In current HSDPA specifications for 1.28Mcps TDD:

- each UE shall be assigned associated DPCH in the uplink and downlink to keep uplink synchronization even if no data is transmitted. Therefore, the number of simultaneous packet data users will be limited due to the code limited downlink and uplink in 1.28Mcps TDD;
- in order to launch HSDPA transmission at any time, UEs are required to monitor one or more HS-SCCHs continuously. If user stays connected over a long time span while there are only occasional periods of data transmission, the UE will consume much power unnecessarily.
- the relative overhead consumed by HS-SCCH becomes significant when it is used to transport small packets, such as those generated in the transport of low-latency low data-rate traffic like VoIP and gaming over HSDPA

According to the current E-DCH specifications for 1.28Mcps TDD:

- Two types of transmission are supported, one is non-scheduled transmission which is always allocated with the reserved and dedicated physical layer resources in a way similar to DPCH; the other is scheduled transmission sharing the common physical resource pool;
- The E-PUCH and E-HICH for non-scheduled transmission can also be used to keep uplink synchronization for UE. So when E-DCH operates together with HSDPA or DPCH, from the point view of keeping uplink synchronization, the associated DPCHs or DPCHs are redundant and some resources are wasteful because E-DCH must operate in parallel with HSDPA or DPCHs
- Not specified or optimized on how to support VoIP traffic；
- No DRX in HSDPA reception;

CPC focuses on the optimization of HSDPA and E-DCH for 1.28Mcps TDD, especially on the scenario that UEs are kept in CELL_DCH state with the connections configured on HS-DSCH and E-DCH only, i.e. without additional DPCH in the uplink or downlink. The SRBs are assumed to be mapped on HS-DSCH in downlink and on E-DCH in uplink. According to the above analysis of HSDPA/E-DCH and the motivation of CPC, we can define the scope of CPC for 1.28Mcps TDD as:

- Eliminating the code limitation to increase the number of packet data user;
- Reducing UE power consumption;
- Optimizing to support VoIP traffic;

9.3 Enhanced CELL_FACH State

Delay in set up or channel allocation is one important measure of quality of service experienced by the subscriber. As analysed in TR25.815, the setup delays on PS and CS domain can be significantly reduced by using HSPA for SRBs. Thus in common understanding, signalling latency when SRBs are mapped on HSPA can meet the target requirements of Rel-7.

In current CELL_FACH state in 1.28Mcps TDD, the signalling delay on FACH and RACH can be seen as one bottle neck compared to signalling speed on HSPA. This can be identified by some "always on" type IMS services, where the UE is typically kept in CELL/URA_PCH state and normally moved to CELL_DCH when DL/UL user plane is activated. The enhancement on signalling bit rates in CELL_FACH state can reduce the signalling delay experienced by the RRC messages when transiting to CELL_DCH.

Moreover, even if the CELL_DCH state is enhanced by work done in Continuous Packet Connectivity (CPC) in 1.28Mcps TDD, it is still faced with the user number limited situation as resource shall be reserved to maintain UL synchronization. In addition, for some low data amount/rate services, keeping UE in CELL_DCH is not preferable when taking the UE power consumption into account. The data rate in CELL_FACH state need to be increased to meet the cases where the CELL_DCH is not preferable.

Thus the enhancement to CELL_FACH shall aim to increase the CELL_FACH data rate and reduce state transition time to CELL_DCH state. In light of the analysis in TR25.815 and the work done in FDD CELL_FACH enhancement, the use of HS-DSCH and HS-PDSCH instead of FACH and S-CCPCH in CELL_FACH state can be investigated to obtain smaller signalling delays and higher bit rate in CELL_FACH state.

The same enhancement can also be introduced in CELL_PCH and URA_PCH state according to the work done in FDD CELL_FACH enhancement. The main benefit is better power and code multiplexing support with HSPA traffic and the possibility to turn off the S-CCPCH in a pure Rel-8 system.

When investigating the enhancement in CELL_FACH state in 1.28Mcps TDD, the following items shall be taken into account:

(a) The basic concept is to use HSDPA in CELL_FACH state. The same HSDPA procedure in REL-5 may be considered, including e.g. the fast feedback mechanism when dedicated H-RNTI is allocated.

(b) As the multi-carrier operation has been introduced in 1.28Mcps TDD in Rel-7, the study shall be based on the multi-frequency architecture, e.g. the work shall be on how HS-DSCH in E-CELL_FACH can be established on secondary frequencies to improve the capacity and peak rate.

(c) The work shall also take the uplink transmission improvement into account, e.g. the uplink random access resource can be considered to set up on secondary frequencies.

9.4 Layer 2 Enhancements

HSPA Evolution is targeting both higher bit rates and spectrum efficiency. However, the current UTRA Layer 2 architecture is not optimised for bit rates higher than 2.8Mbps (MIMO and potential other technologies like 64QAM provides data rates beyond 2.8Mbps).

The problem stems from that AM RLC uses a fixed RLC PDU size. In order to avoid RLC window stalling the RLC PDU size needs to be increased which leads to excessive padding and coverage issues. This rigidity in the Layer 2 protocol means that both link adaptation and cell coverage will be sub-optimal when higher bit rate schemes are being considered.

The current Layer 2 overhead of fixed RLC SDU segmentation and MAC-hs layer padding also poses a problem for the HSPA Evolved system efficiency.

FDD solution to reach high data rates and reduce protocol overhead and padding is to apply flexible RLC PDU sizes in downlink. The support of flexible RLC sizes could also be made available for the UL. Similarly to the downlink, this will lead to performance improvement in the support for higher data rates, reduced protocol overhead and padding in the uplink.

LCR TDD Enhancement of the Layer 2 protocol in the context of HSPA evolution will consider the following points which has been discussed in FDD:

- **RLC:** The RLC AM protocol is evolved into supporting flexible PDU sizes
- **MAC:** The MAC-hs protocol is evolved into supporting RLC PDU segmentation.

The applicability of these points shall be evaluated and the aspects applicable to LCR TDD shall be inherited and further LCR TDD specific enhancements shall also be considered to facilitate HSPA Evolution.

9.5 Downlink 64QAM Modulation

9.4.1 Link-level study of 64QAM in downlink

An “SNR/rate-lookup” simulation was used to evaluate the impact on throughput of introducing 64QAM into the MCS, just like Ericsson did in “R1-062264: 64QAM for HSDPA – Link-Level Simulation Results” from Ericsson” for FDD system. This method allows an expedient yet accurate assessment of the radio link in question. Essentially, this simulation consists of:

- generating the appropriate channel realization,
- determining a MMSE-BLE receiver combining solution as a function of this channel realization,
- analytically calculating the output symbol SNR for the receiver,
- looking up the maximum supportable rate of the output SNR from an MCS table (shown in the appendix),
- averaging this maximum supportable rate over many channel realizations (assumes ideal link adaptation).

The MCS table, as the name implies, gives us the modulation and coding scheme which is best for the operating conditions. However, it does not give us the transport format, which includes the number of spreading codes and timeslots employed. Throughout, we will assume that 3 timeslots are available and 16 HS-PDSCH codes at spreading factor 16 per timeslot, and all timeslots and codes will be used by the UE. The simulation parameters are summarized in Table 1.

Table 1: Simulation parameters

Parameter	Assumption
Number Carrier	1
Number timeslots	3
Number HS-PDSCH codes per timeslot	16
Spreading factor	16
Receiver	1 Rx Antenna, MMSE-BLE
Channel estimation	Zero Forcing + Post Processing
Channel model	AWGN, Pedestrian A/B, and Vehicular A
UE speeds of interest	0km/h, 3km/h, 30km/h
EVM model	none

Figures 1 to 4 show average throughput versus `Ior over Ioc` for AWGN, Pedestrian A and B, and Vehicular A channels, respectively.

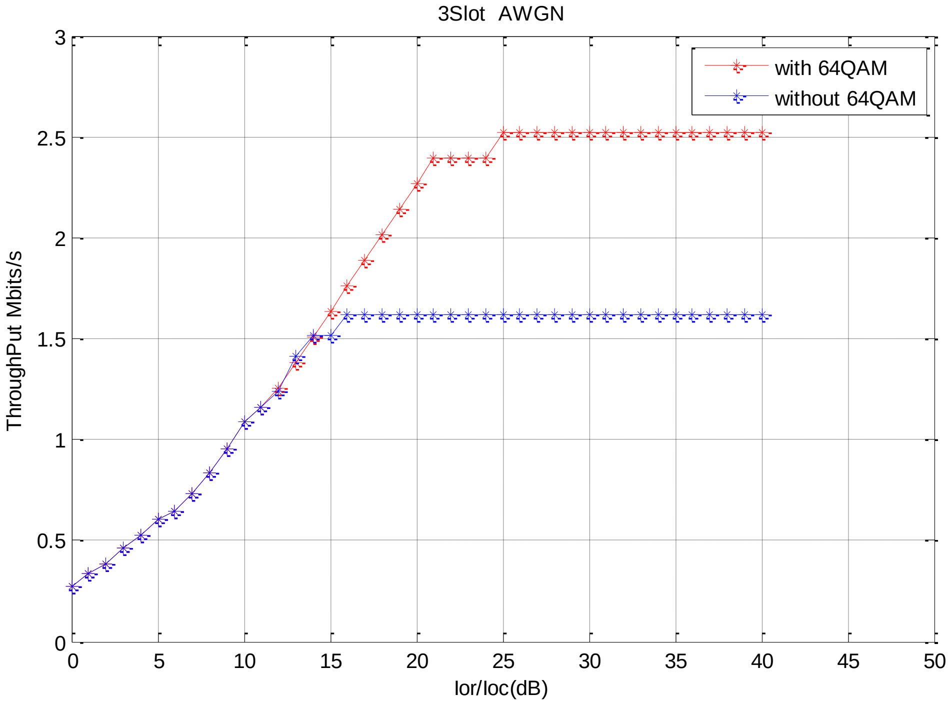

Figure 1: Average throughput for AWGN channel.

For AWGN channel, the maximum rates of 2.5Mb/s and 1.68Mb/s are apparent in the clipping of the 64QAM-inclusive and the current non-64QAM cases. We note that when `Ior over Ioc` increased to 18dB and above, the 64QAM inclusive case will have the throughput gain than non-64QAM case.

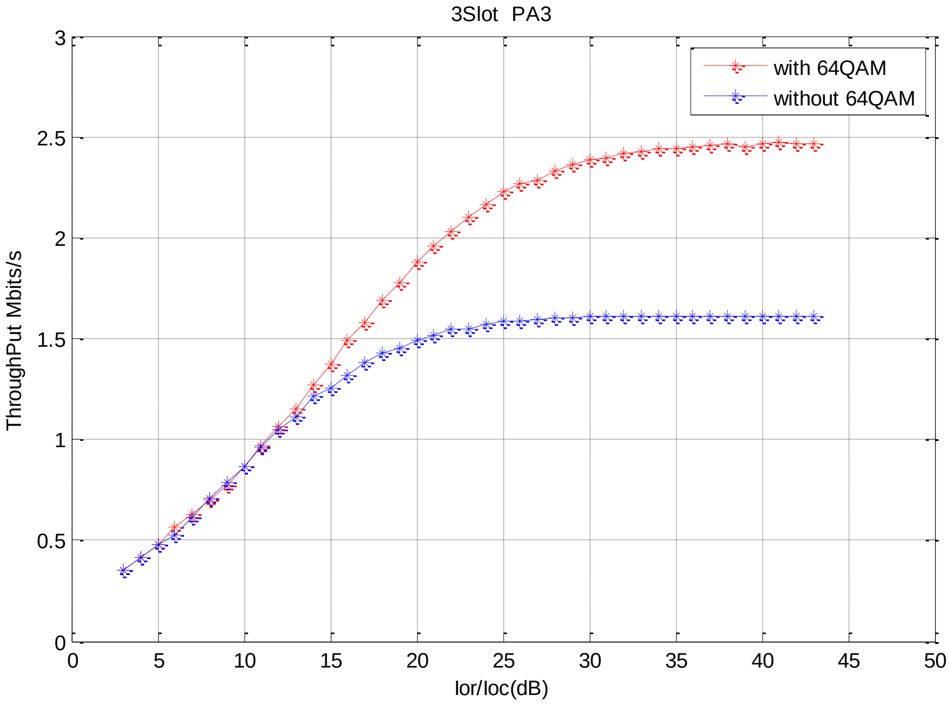

Figure 2: Average throughput for Pedestrian A channel with 3km/h UE velocity.

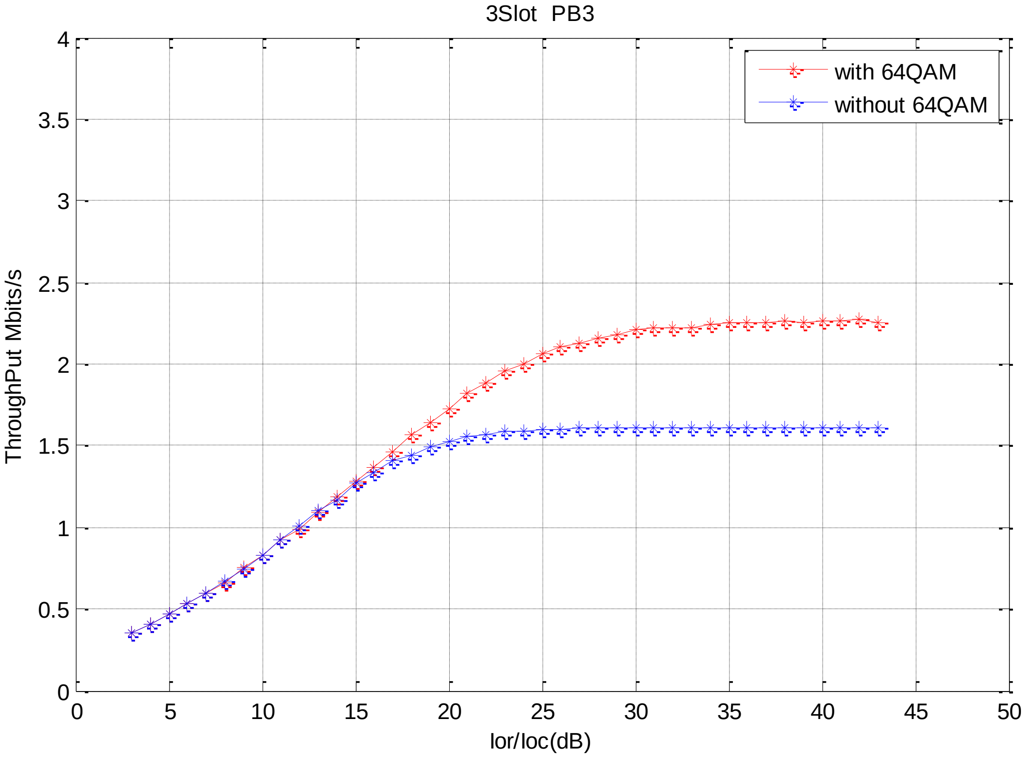

Figure 3: Average throughput for Pedestrian B channel with 3km/h UE velocity.

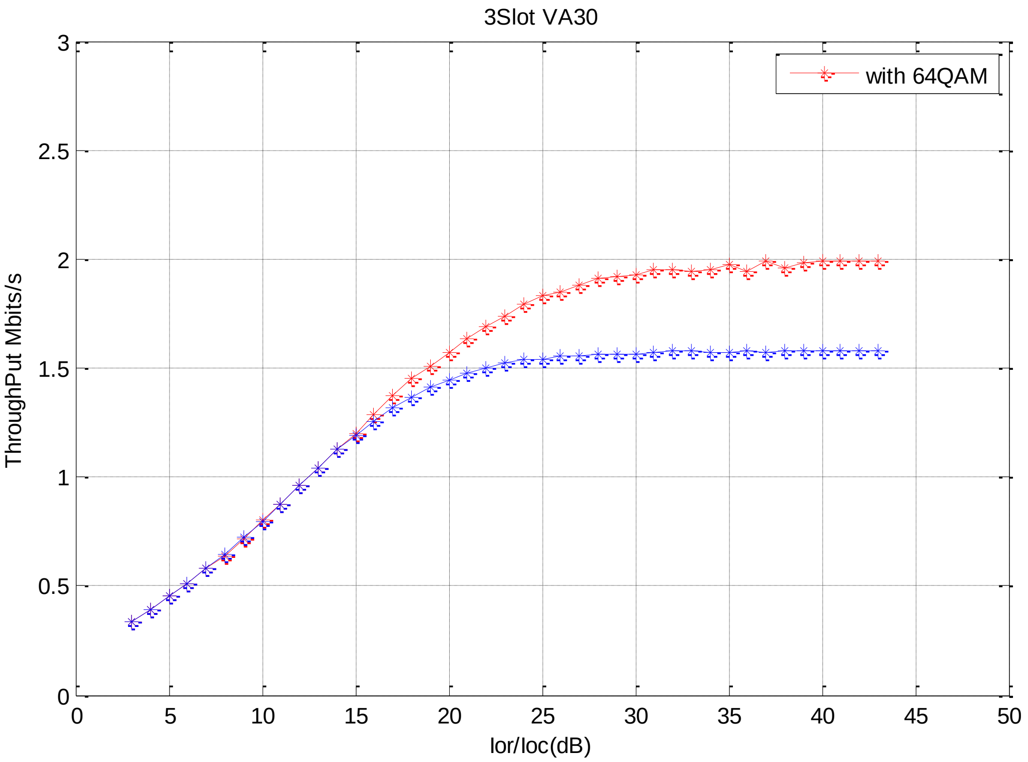

Figure 4: Average throughput for Vehicular A channel with 30km/h UE velocity.

For different fading channels, current non-64QAM case will achieve the maximum throughput of 1.6 Mb/s. But the 64QAM-inclusive case can only achieve its maximum throughput of 2.5Mb/s for PA3 channel, while a reduced 2.3Mb/s for PB3 channel and 2.0Mb/s for VA30 channel. The more dispersive of the fading channel, the worse symbol SNR we will get in the receiver, which leads to a significant reduction in throughput performance. However, even for the high dispersive VA30 channel, 64QAM will introduce about a 25% throughput increase.

Actually, the throughput performance list above is achieved by employing one HSDPA carrier with 3 full-codes HS-PDSCH timeslots (altogether 3*16=48 codes). Much higher HS-DSCH throughput can be achieved when we employ more carriers and timeslots.

If considering CQI feedback delay and HARQ retransmission, the simulation parameters are summarized in Table 2.

Table 2: Simulation parameters of considering CQI feedback delay and HARQ retransmission

Parameter	Assumption
Carrier Frequency	2 GHz
Chip Rate	1.28 Mcps
TTI length	5 ms
Number of timeslot	5
HARQ	Chase Combining, 4 HAP Maximum retransmission number: 4
AMC	On
CQI feedback delay	2 TTI
Spreading Factor	16
Number of multi-codes	16
Midamble code allocation	Common
Channel Model	AWGN/PA3/PB3/VA30
Channel Estimation	Realistic post-processing
Detection Algorithm	MMSE-BLE Joint Detection

The simulation results of considering CQI feedback delay and HARQ retransmission are showed as Figure 5 to Figure 8.

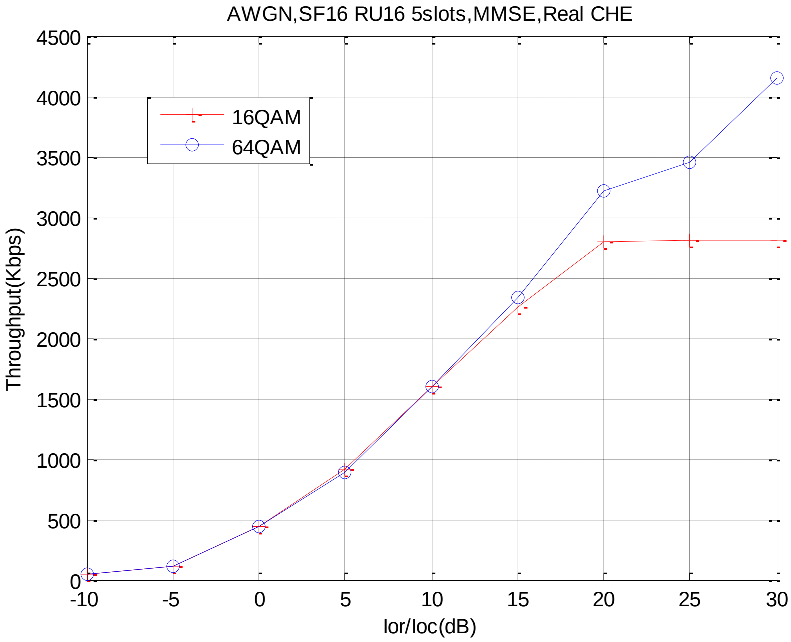

Figure 5: Average throughput for AWGN channel.

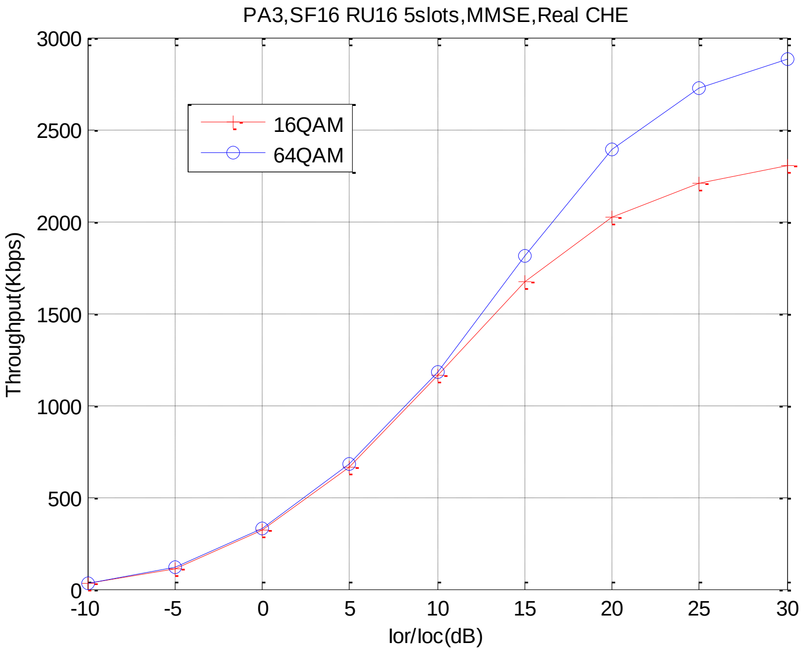

Figure 6: Average throughput for Pedestrian A channel with 3km/h UE velocity.

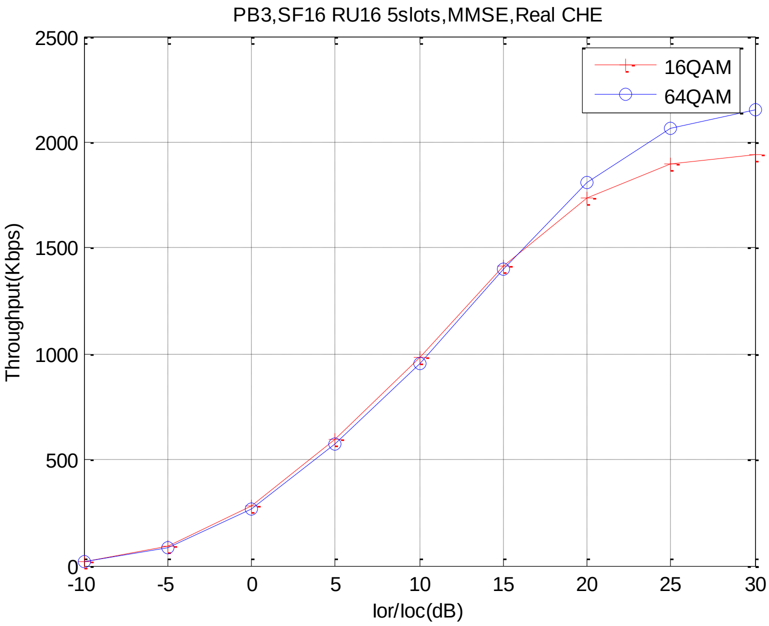

Figure 7: Average throughput for Pedestrian B channel with 3km/h UE velocity.

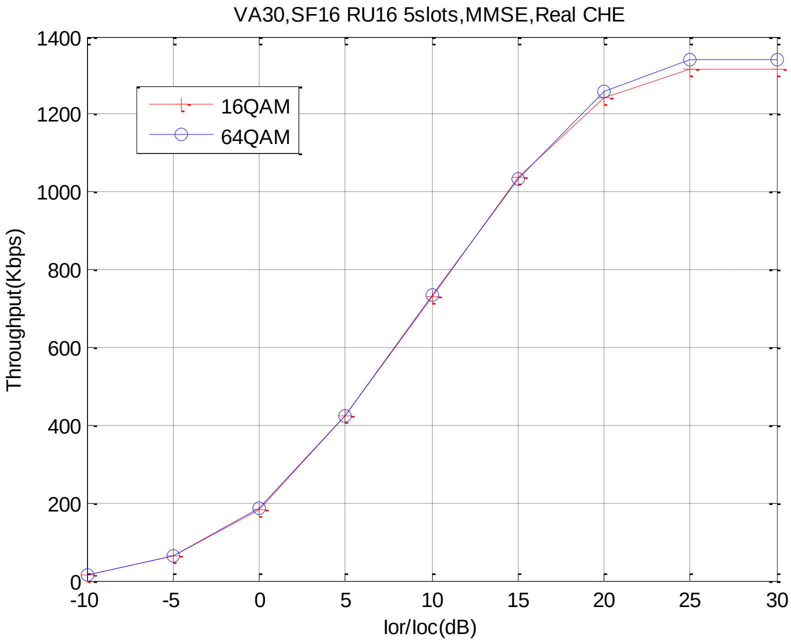

Figure 8: Average throughput for Vehicular A channel with 30km/h UE velocity.

9.4.2 System-level study of 64QAM in downlink

9.4.2.1 Indoor Micro-Cell Scenario

The Indoor Micro-Cell simulation scenario is showed as Figure 9 and the simulation parameters are summarized in Table 3..

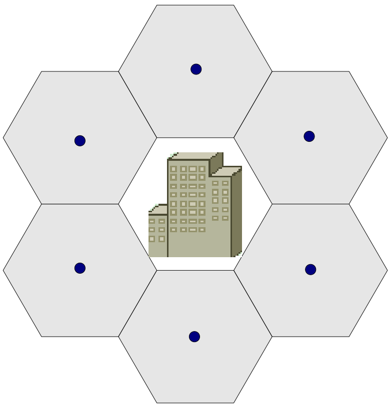

Figure 9: Indoor simulation scenario.

Table 3: Indoor Simulation parameters

Parameter	Assumption
Cellular Layout	3 Indoor cells in the middle of interest + 6 surrounding outdoor cell sites (3 sectors per site) as interference. (Fig. 1)
RRU ports per Indoor cell	4
Indoor Floors of coverage per RRU port	3
Ceiling Mount Antennas per Floor	9
Indoor Building (Floor) Size	50m × 50m
Tx Carrier Power per RRU Port	25.2dBm
Max Tx power of Ceiling Mount Antenna	9dBm
Ceiling Mount Antenna Gain	3dBi
Indoor MCL	39dB
Indoor FAF	21dB
Channel model	Single Path of Rayleigh Fading
UE speeds of interest	0.2km/h Indoor
Indoor Shadowing standard deviation	8 dB
Outdoor ISD	200m
Outdoor BS Tx power per Carrier	34dBm
Outdoor BS antenna gain	15dBi
Penetration Loss	20 dB
Feeder Loss	1dB
Outdoor MCL	70dB
UE antenna gain	0 dB
UE noise figure	8 dB
HS-PDSCH Carrier/TS/Code Configuration	1carrier × 3TS × 16codes
Scheduler	Proportional Fair

Figure 10 shows the indoor simulation results.

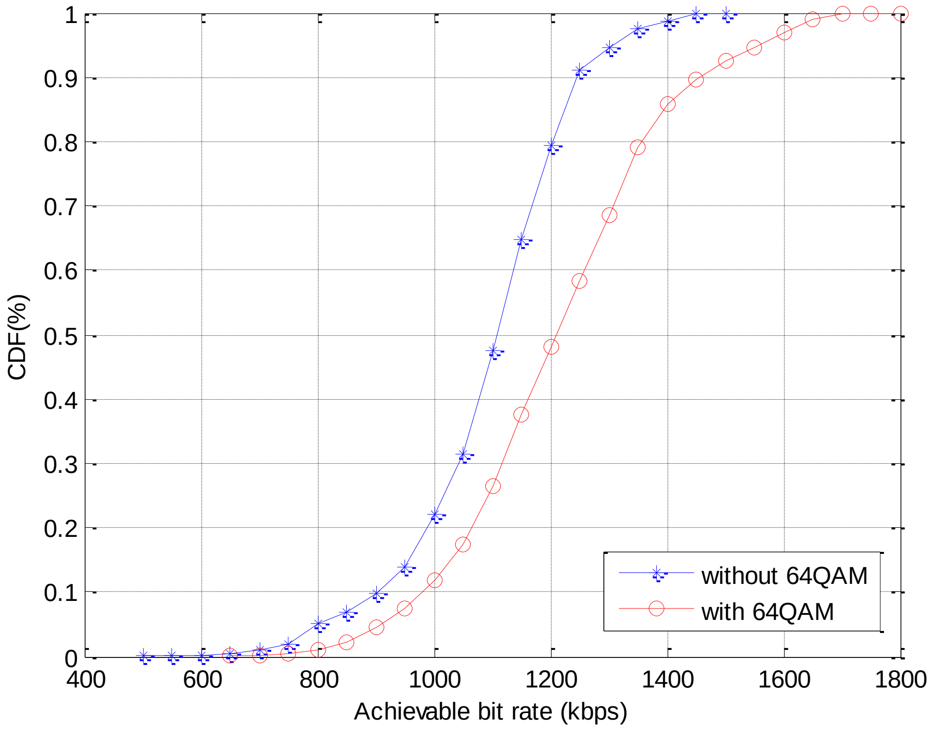

Figure 10: Indoor simulation results.

In the indoor micro-cell scenario, the opportunities of using 64QAM are more because the UE received SNR is higher. The cell throughput can be improved effectively by using 64QAM from the indoor simulation results.

9.4.2.2 Outdoor Macro-Cell Scenario

The simulation parameters are summarized in Table 4.

Table 4: Outdoor Simulation parameters

Parameter		Assumption
Cellular Layout		Hexagonal grid, 19 cell sites, 3 sectors per site, wrap-round
Inter-site distance (ISD)		645 meters
Shadowing standard deviation		6 dB $d \le dc$ 8 dB $d > dc \quad dc = 380 meters$
Shadowing correlation	Between cells	0.5
	Between sectors	1.0
BS antenna gain		15dBi
Penetration Loss		20 dB
Feeder Loss		1dB
Channel model		Typical Dense Urban, Single Path of Rayleigh Fading
UE speeds of interest		3 km/h
Total BS TX power per Carrier		34 dBm
Average BS TX power surrounding cells		Scenario dependent (Pavg)
UE noise figure		8 dB
UE antenna gain		0 dB
HS-PDSCH Carrier/TS/Code Configuration		1carrier×3TS×16codes
UE Height		1.5m
BS Height		30m
Fast Fading Model		Rayleigh
Scheduler		Proportional Fair

Figure 11 shows the outdoor simulation results.

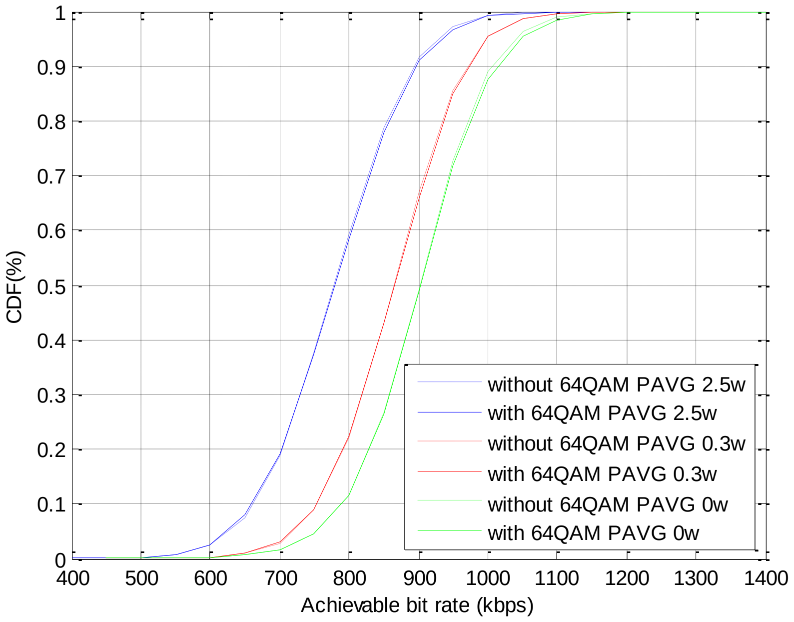

Figure 11: Outdoor macro-cell simulation results.

64QAM can not give significant improvements for the cell throughput in outdoor scenarios from the simulation results. Furthermore the cell throughput improvements of using 64QAM are also limited by reducing interference power from neighboring cell.

9.4.2.3 Outdoor Micro-Cell Scenario

The simulation parameters are summarized in Table 5.

Table 5: Outdoor Simulation parameters

Parameter		Assumption
Cellular Layout		Hexagonal grid, 19 cell sites, 3 sectors per site, wrap-round
Inter-site distance (ISD)		645 meters
Shadowing standard deviation		6 dB $d \le dc$ 8 dB $d > dc$ $dc = 380 meters$
Shadowing correlation	Between cells	0.5
	Between sectors	1.0
BS antenna gain		15dBi
Penetration Loss		20 dB
Feeder Loss		1dB
Channel model		Typical Dense Urban, Single Path of Rayleigh Fading
UE speeds of interest		3 km/h
Total BS TX power per Carrier		34 dBm
Average BS TX power surrounding cells		Scenario dependent (Pavg)
UE noise figure		8 dB
UE antenna gain		0 dB
HS-PDSCH Carrier/TS/Code Configuration		1carrier×3TS×16codes
UE Height		1.5m
BS Height		10m
Fast Fading Model		Rician,the power versus of LOS over NLOS is equal to 1.
Scheduler		Proportional Fair

Figure 12 shows the outdoor simulation results.

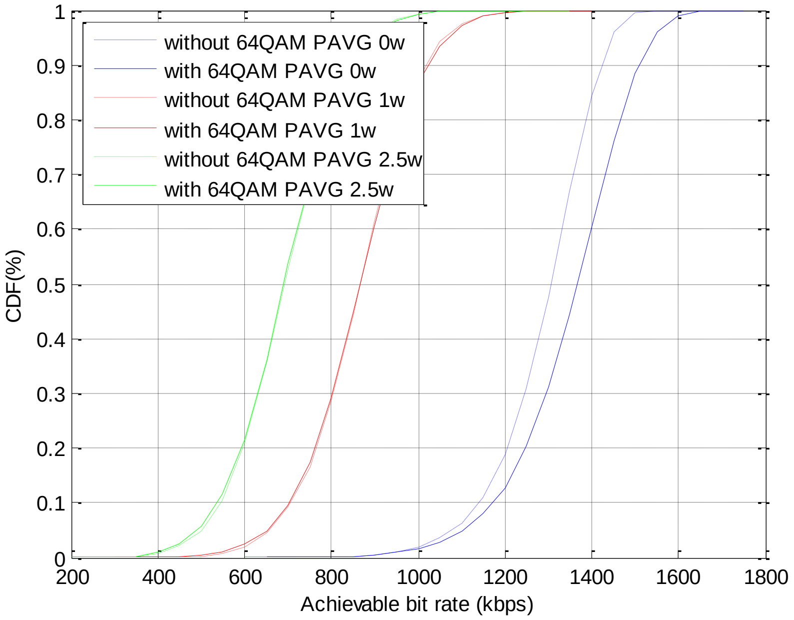

Figure 12: Outdoor micro-cell simulation results.

From the simulation result we can conclude that the cell throughput improvements of using 64QAM can be obtained by reducing interference power from neighboring cell.

9.4.3 Scope of 64QAM in HSPA Evolution for 1.28Mcps TDD

In light of the link-level and system-level simulation results of 64QAM for LCR TDD system with low and high dispersion channels, significant gains were observed by the provision of 64QAM in scenarios where users can benefit in terms of increased throughput from favorable radio conditions such as in indoor system solutions or well tuned outdoor systems.

9.6 MIMO

MIMO (Multiple Input Multiple Output) refers to multi antenna technology and means the use of multiple antennas at transmitter and receiver side in order to exploit the spatial dimension of the radio channel by either the diversity to increase the reliability of data transmission or the multiplexing to increase the throughput of data transmission. The current TDD system usually employs 6 or 8 antennas at NodeB to improve the system throughput and coverage, therefore, for MIMO or exactly data multiplexing beamforming in combination of the multiplexing is hired for utilize the 8 antennas as 8x2 data multiplexing instead of taking the 2x2 MIMO as baseline in FDD.

9.6.1 Simulation assumptions

Link and system level simulation assumptions are summarized in table 9.6.1.1 and table 9.6.1.2 respectively.

Table 9.6.1.1 Assumptions for link level simulation

Parameters	Value
Chip Rate	**1.28 Mcps**
TTI length	**5 ms**
Number of timeslot	**3**
Weight optimization criterion for	**Maximization of the received power of the stream with the**

D-TxAA	**better channel condition**
Codebook for D-TxAA	$\{w_1, w_2, w_3, w_4\}$ $w_3 = w_1 = 1/\sqrt{2}$, $w_4 = -w_2$ $w_2 \in \left\{ \frac{1+j}{2}, \frac{1-j}{2}, \frac{-1+j}{2}, \frac{-1-j}{2} \right\}$ **w1 and w2 for the stream with the better channel condition**
Weight calculation	**Ideal**
Weight delay	**UL-DL slot and 1 TTI**
HARQ	**Chase Combining, 4 HAP** **Maximum retransmission number: 3**
AMC	**On**
CQI feedback delay	**2 TTI**
Spreading Factor	**16**
Number of multi-codes	**16**
Channel Model	**SCM CASEI, CASEIII**
Channel Estimation	**Realistic post-processing**
Detection Algorithm	**MMSE-BLE Joint Detection**

Table 9.6.1.2 Assumptions for system level simulation

Parameter	Explanation / Assumption
Cellular layout	19 NodeB, 3-sector cell sites
Antenna horizontal pattern	70 deg(-3dB) with 20 dB FBR(3-cell sites) (as defined in SCM)
Site to site distance	3000m (scenario I)) or 1000m (scenario II)
Propagation model	Scenario I: L = 34.5 + 35log10(d), according to SCM Urban Macro, (SigmaAS = 8°) Scenario II: L = 34.53 + 38log10(d), According to SCM Urban Micro (NLOS)
Power allocated to HS-PDSCH transmission	100% (MIMO transmissions exist in separate timeslots to those containing control and other channels)
Standard deviation of slow fading	8 dB (Scenario I), 10dB (Scenario II) (as defined in SCM)
Correlation between sectors	1.0
Correlation between sites	0.5
Carrier frequency	1900MHz
BS Antenna Num	2 (default spacing: 4 λ) or 8 (default spacing: 0.5 λ)
UE Antenna Num	2 (default spacing: 0.5 λ)
BS antenna gains	14dBi (as defined in SCM)

UE antenna gain	0 dBi
UE noise figure	9 dB
BS total Tx power	43dBm (for both 2 antennas and 8 antennas)
Thermal noise density	-174dBm/Hz
Num of Users per Cell	10 UEs per sector
Traffic Model	Full Buffer
HS-SCCH Decoding	Ideal
CQI feedback delay (TTI)	2TTI, 10ms
Feedback error	0%
Fast HARQ scheme	Chase Combining, 6 HARQ processes
Max Retransmission Num	3 (in addition to initial transmission)
Receiver Type	Linear MMSE
MCS Selection	10% initial transmission BLER
Schedule Algorithm	Proportional Fair
Building Penetration	0 dB
UE speed	3km/h
Number of HS-PDSCH timeslots	3 per subframe

9.6.2 Two-antenna case

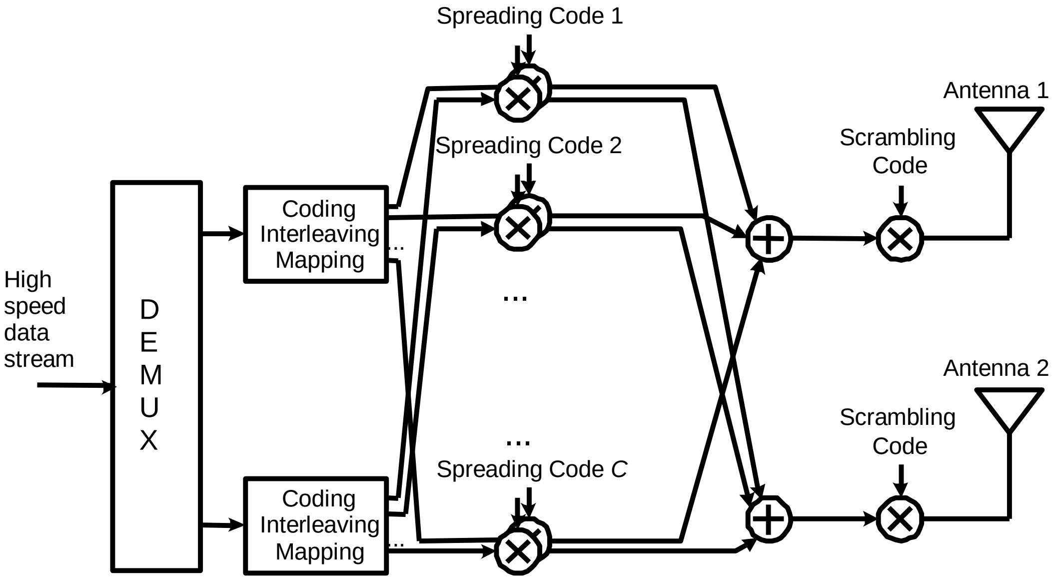

Figure 9.6.2-1: Example of two-antenna PSRC structure [4]

9.6.3 8-antenna case

Three MIMO schemes considering the combination of the beamforming and the multiplexing are briefed. The combined MIMO considered in 8 or 6 antennas at NodeB in TDD system usually utilizes the reciprocal uplink channels for the DL beamforming.

Alternative 1.

The first one is a usual beamforming case with one stream and one beamforming data transmission as figure 2 depicted. The difference from the non-MIMO case is that UE has two or more antennas, which helps UE achieves additional receive diversity gain. The beams are obtained by EBB (Eigenvector Based Beamforming), which decomposes the correlation matrix of the MIMO spatial channel and chooses the eigenvector corresponding to the largest eigenvalue.

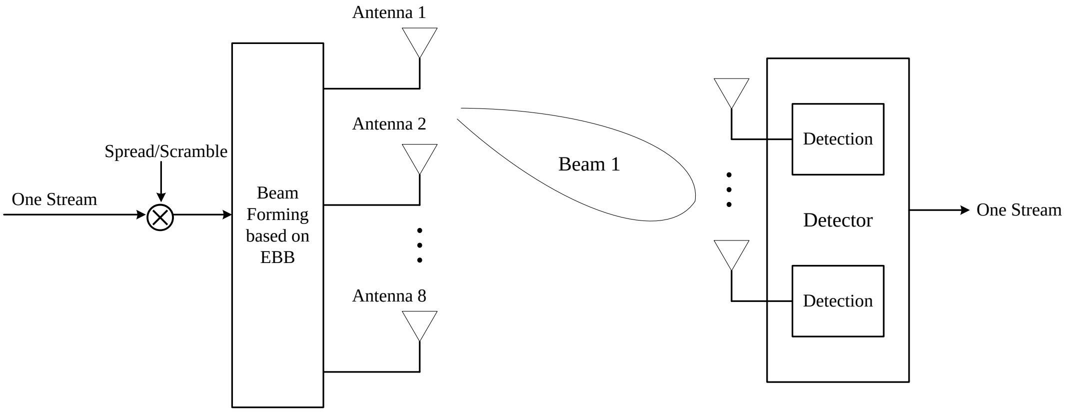

Figure 9.6.3-1: Single beamforming stream transmission based on EBB

Alternative 2.

The second method is to treat the 8 antennas at NodeB as a whole. Two beams are formed according to the UL channels and each carries one data stream. The two beams are generated by EVD (EigenValue Decomposition) of the channel correlation matrix or SVD of the channel matrix. The beams are chosen by the two eigenvectors corresponding to the largest two eigenvalues derived by EVD or SVD, i.e. precoding technology.

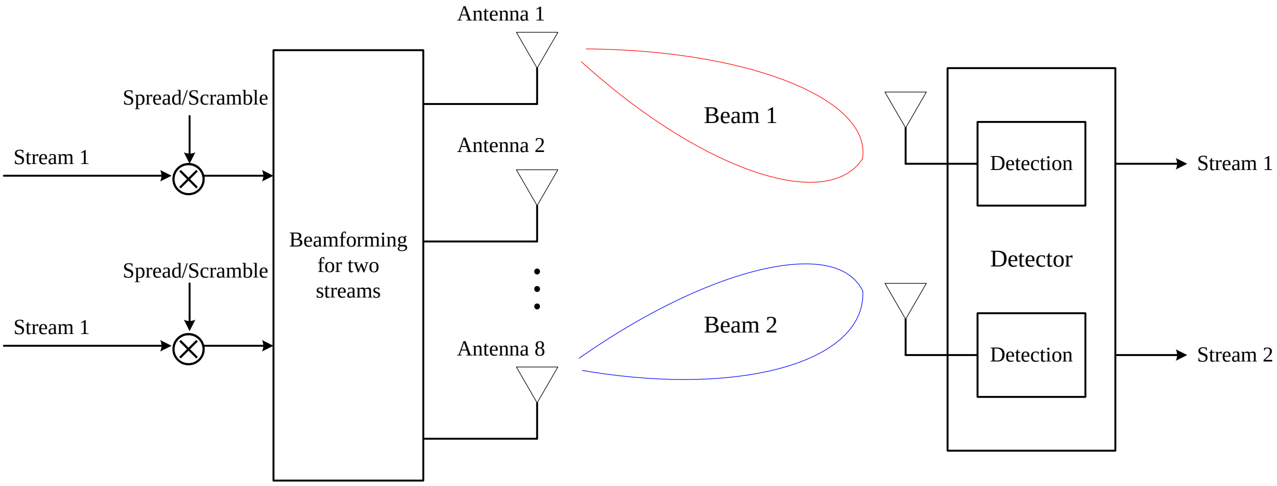

Figure 9.6.3-2: Double beamforming stream transmission based on SVD MIMO

Alternative 3.

The third method is to divide the multiple antennas at NodeB into 2 four-antenna groups. For each group, one beam is formed corresponding to the UE and together two beams carry two streams for data multiplexing. With aid of this approach, precoding technology can be further adopted to the two data streams before the data are weighted by the two eigen beams, which are generated based on the effective channels when the channels with each group are handled independently. The problem how to classify different antennas to two groups is up to deployment environment and antenna configuration.

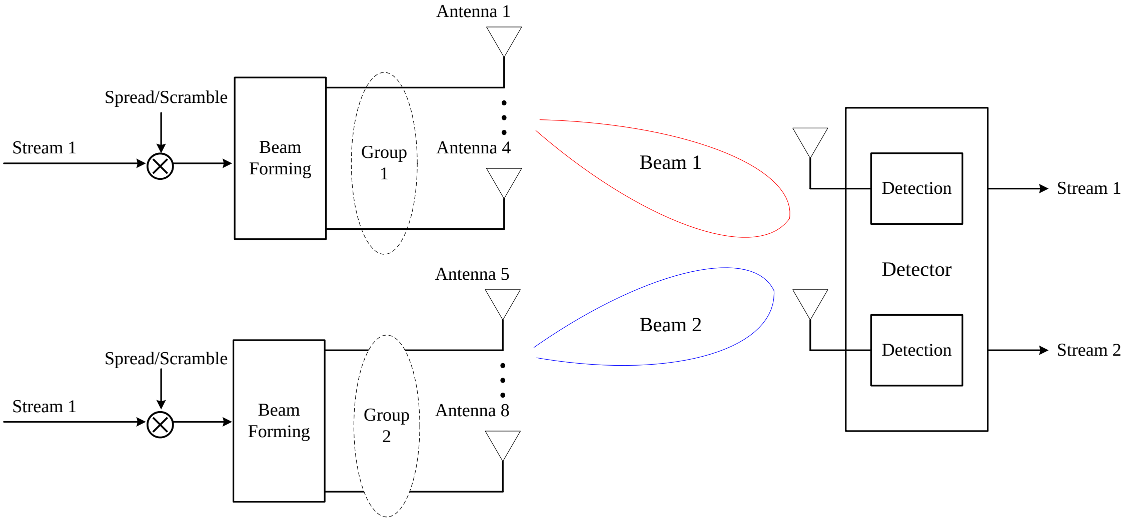

Figure 9.6.3-3: Double beamforming stream transmission based on antenna grouped MIMO

In some scenarios, the correlation of the channels changes with time, switching between the alternative 1&2 or alternative 1&3 would achieve more throughput than only one MIMO scheme employment. We can take the switching scheme as the fourth method. This diversity and multiplexing switching depends on the channel quality and correlation between the NodeB and UE by either the MMSE or channel capacity criterions which are considered in implementation nowadays.

On top of separate use of aforementioned alternative, the multiple antenna system could also adopt adaptive transmission switching between alternative 1 and alternative 2, alternative 1 and alternative 3 to obtain a better performance.

9.6.4 Generic PSRC

Comprehensively taking account of 2-antenna and 8-antenna case, a generic PSRC antenna structure was proposed as 1.28Mcps TDD MIMO scheme (figure 9.6.4-1).

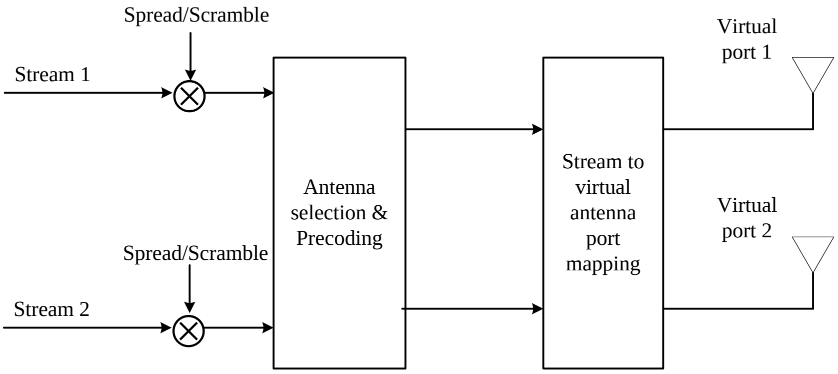

Figure 9.6.4-1: Generic PSRC antenna structure

In this generic PSRC structure, a suitable non-codebook MIMO scheme for 1.28Mcps TDD, the data streams with their own rate control are mapped on actual antenna port, which accounts for real antenna port for 2 antenna case(figure 9.6.2-1) and virtual eigenvector identified antenna port for 8 antenna case depicted above.

10 Conclusions and Recommendations

11 Work Plan

Note: This chapter will capture text dealing with a proposed work plan.

Annex A:
Change history

Change history							
Date	**TSG #**	**TSG Doc.**	**CR**	**Rev**	**Subject/Comment**	**Old**	**New**
2007-10	RAN1#50 bis	R1-0745xx			Skeleton Version	-	0.0.1
2007-11	RAN1#51				- text proposal included as agreed in R1-074823, R1-074824, R1-074825	0.0.1	0.0.2
2007-11	RAN1#51				-email approval	0.0.2	0.1.0
2008-05	RAN1#53				- text proposal included as agreed in R1-080565, R1-081352	0.1.0	0.1.1
2008-05	RAN1#53				- text proposal included as agreed in R1-082116	0.1.1	0.1.2
2008-05	RAN#40				- Document moved up to v1.0.0	0.1.2	1.0.0
28/05/08	RAN#40	RP-080333	-	-	Document is approved and put under change control	1.0.0	8.0.0