Global TD-LTE Initiative (GTI)

Estimation and Validation of TD-LTE coverage

Network Planning Task Force

Tokyo, 25th -26th on Apr 2012

TF Scope

- Conclusion review in 2011
  - Frequency Reuse 1 has better SE and final THR, less sensitive to burst increasing system load with the maturity of the network infrastructures
  - TD-LTE network can flexibly adapt its DL/UL resource partition to meet requirements of different traffic models
- Objective in 2012
  - How to do coverage planning of LTE?
  - Estimation of TD-LTE coverage
  - TD-LTE trial results sharing
  - What are the solutions for problems we faced in coverage?

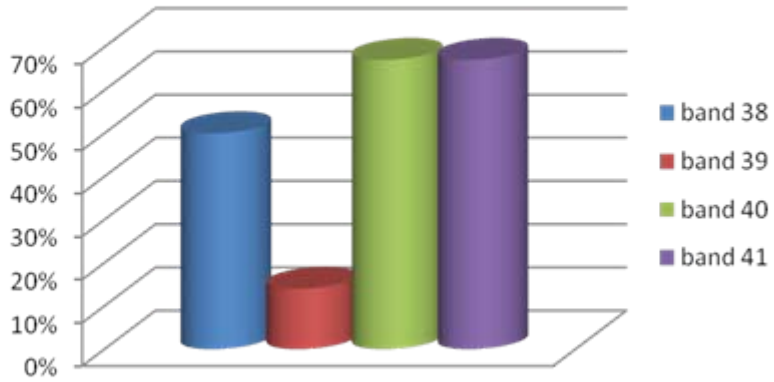
Influence factors of coverage-Survey Results

operator	scenario and percentage						
	Dense urban	Urban	Suburban	Rural	Mountain area	Sea area	road
Belltel	2%	**53%**	26%	13%	50% of Philippines		7%
CMCC	19%	49%	32%				
FarEstone	2%	9%	9%	**79%**			
Iburst	5%	40%	25%	25%	5%		
Tatung	2%	2%	18%	23%	55%		
Nextwave	2%	3%	**85%**	10%			
Omantel	5%	15%	30%	30%	5%	15%	

2012

TBD

available frequency band percentage

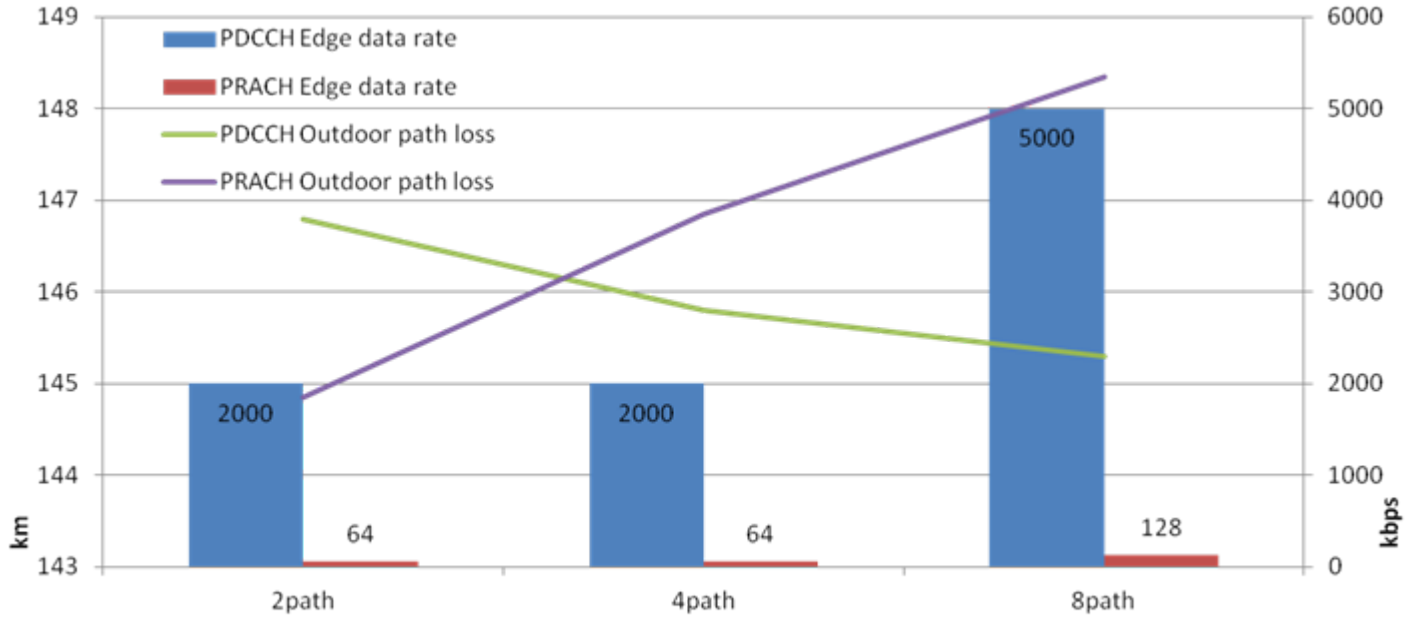


38	2570 MHz - 2620 MHz
39	1880 MHz - 1920 MHz
40	2300 MHz - 2400 MHz
41	2496 MHz - 2690 MHz

- **Scenario ,frequency band and antenna configuration are all important factors which should be paid more attention**
  - **Different scenario, different shadow fading margin**
  - **Different frequency band, different penetration loss and antenna gain**
  - **Different antenna configuration, different antenna gain**

Link Budget

With the same frequency band(38) and scenario(dense urban), antenna gain and receive diversity gain are the causes of path loss and limiting channel difference



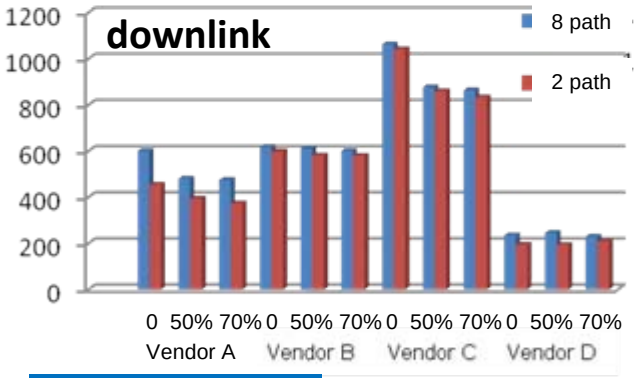
- **Antenna configuration:**
  - **PDCCH coverage depends on antenna gain: 2 path>4 path>8 path**
  - **PRACH coverage depends on receive diversity gain and antenna gain: 8 path>4 path>2 path**
  - **Limiting control channel coverage: 4 path>8 path>2path**
- **Comparison between TDD and FDD:**
  - **control channel of TD-LTE(2 path) & LTE FDD(2 path) has the same coverage**

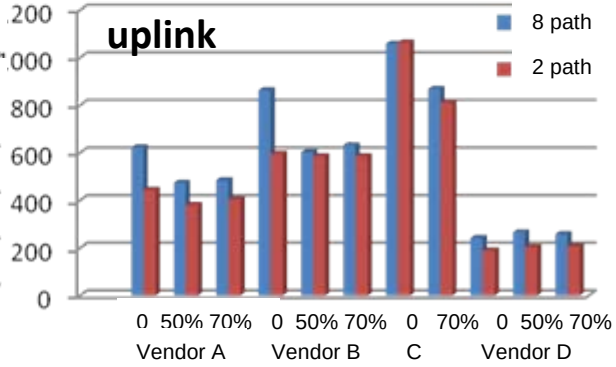
Trial Results-2/8 path antenna

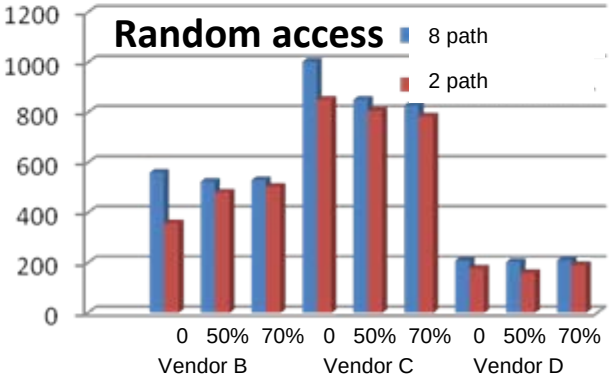
Condition

- Test environment: urban, $h_{BS} = 30 \sim 40m, ISD = 500m$ /dense urban, $h_{BS} = 20 \sim 30m, ISD = 300m$
- Network Configuration: band 38 , 20MHz bandwidth, frequency reuse factor=1, 3 sectors/cell
- Antenna configuration: 2 path(17.5~18dBi),8 path(16~16.5dBi)
- Test method: test UE(always locked in the serving cell PCI) goes straight along the antenna normal direction

Results







Conclusion

- With same type of antenna, the coverage of UL¥DL (call drop point)is close to each other; the coverage of random access point is nearer than them
- From call drop point of view, Compared to 2 antenna, DL coverage gain of 8 antenna is 13.21%,UL coverage gain of 8 antenna is 20.71%(coverage gain=(D8-D2)/D2)
- From edge data rate at 5Mbps point of view, Compared to 2 antenna, DL coverage gain of 8 antenna is 39%,UL coverage gain of 8 antenna is 44.56%

Trial results- penetration loss

Condition

- Goal : to get reserved margin from outdoor to indoor at different band
- Method :by testing outdoor and indoor signal strength at either side of different materials on the same horizon level
- Materials: glass (window), bearing wall, multilayered wall (indoor, far away from window)
- Configuration: frequency reuse factor=1, 3 sectors/cell, Bandwidth=20MHz, Dense urban area, (different band result got from present network under the same sites with LTE)

Results

Frequency / materials	900MHz	1800MHz	2GHz	2.6GHz
Glass(Window)	0	N/A	9	10
Glass screen wall	N/A	6.24	7.18	10.61
Concrete wall	12.61	N/A	15.18	19.90
multilayered wall	28	N/A	35	43

Conclusion

- Penetration loss variance will be influenced by materials and frequency band variance. The thicker material is , the larger penetration loss variance between different frequency band. Usually, penetration loss under 2.6GHz will be higher 4~15dB than 2GHz except glass window

Summary

- **Link budget analysis**
  - Control channel coverage of 4&8 path antenna is better than 2 path antenna
  - At the access point, edge data rate of 8 path antenna is the best (DL:5Mbps,UL: 128kbps)
  - Control channel of TD-LTE(2 path) & LTE FDD(2 path) has the same coverage

- **Coverage performance evaluation**
  - Coverage distance
    - Call drop point: 13% longer than 2 path antenna in down link and 21% longer in up link in average
    - Data rate at 5Mbps : Compared to 2 antenna, DL coverage gain of 8 antenna is 39%,UL coverage gain of 8 antenna is 44.56%
  - Penetration loss under 2.6GHz will be higher 4~15dB than 2GHz except glass window

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Thank you!

Annex 1 - propagation model(1)

HATA propagation model

$$L_{urban} = 69.55 + 26.16\log(f_{MHz}) - 13.82\log(h_{BS}) - A(h_{mobile}) + (44.9 - 6.55\log(h_{BS}))\log(d_{km}) \quad (dB)$$

$$A(h_{mobile}) = (1.1\log(f_{MHz}) - 0.7)h_{mobile} - (1.56\log(f_{MHz}) - 0.8) \quad (\text{small} - \text{medium city})$$

$$A(h_{mobile}) = 3.2\,(\log(11.75\,h_{mobile}))^2 - 4.97 \quad (\text{large city},\ f \geq 400\ \text{MHz})$$

$$L_{suburban} = L_{urban} - 2\left(\log(f_{MHz}/28)\right)^2 - 5.4 \quad (\text{dB})$$

$$L_{ro} = L_{urban} - 4.78\left(\log(f_{MHz})\right)^2 + 18.33\log(f_{MHz}) - 40.94 \quad (\text{dB})$$

Valid for $1 \leq h_{mobile} \leq 10m$ $30 \leq h_{BS} \leq 200m$ $150 \leq f \leq 1500$ MHz $1 \leq d$ km

Annex 1 - propagation model(2)

Cost 231 HATA propagation loss model

$$L_{urban} = 46.3 + 33.9\log(f_{MHz}) - 13.82\log(h_{BS}) - A(h_{mobile}) + (44.9 - 6.55\log(h_{BS}))\log(d_{km}) + C_M \quad (dB)$$

$A(h_{mobile})$ is as given for the Hata model

$C_M = 0$ dB for medium sized city and suburban centres with moderate tree density

$C_M = 3$ dB for metropolitan centres (CBD)

$$L_{suburban} = L_{urban} - 2\left(\log(f_{MHz}/28)\right)^2 - 5.4 \quad (\text{dB})$$

$$L_{ro} = L_{urban} - 4.78\left(\log(f_{MHz})\right)^2 + 18.33\log(f_{MHz}) - 40.94 \quad (\text{dB})$$

Valid for : $f \geq 1500$ MHz, $30 \leq h_{BS} \leq 200$ m, $1 \leq h_{mobile} \leq 10$ m

$1 \leq d \leq 20$ km

Annex 2 - Scenario Definitions

Scenario	Description
Dense urban	Complex wireless transmission environment, average height of buildings is above 40 meters， density of large building is higher than 35%.Typical area is CBD， most users here have larger demand on voice、 data service and higher QOS requirements
Urban	Average height of buildings is less than 40 meters， density of building is between 8%~35%.Typical area is residential area, service requirement here is lower than dense urban
Suburban	Average height of buildings is less than 20 meters， density of building is between 3%~8%.Typical area is park、 industrial area and blocks, service requirement here is close to urban area
Rural	Open area, average height of buildings is less than 20 meters， density of building is less than 3%.Typical area is village with small population. Service requirement here is small as well
Mountain area	Terrain and signal strength change greatly and variously, Service requirement here is small but necessary for life saving

Global TD-LTE Initiative

GTI Taskforce Multi-Antenna Solutions & Specifications Report

CMCC

TF Lead: Ma Xin

Date: 16,April

Basic TF information

- TF:
  - Multi-Antenna Solutions & Specifications (Ab. MASS)
- Background：
  - In GTI, we have researched the basic multi-antenna beamforming algorithm and achieved the conclusion: BF is very important feature in TDD system to improve network performance
  - In this new TF, we would like to focus on the multi-antenna products and solutions during the procedure of commercial applications
- Scope &objectives:
  - Common requirements for TDD multi antenna products
  - Solutions for compact antenna & co-site antenna requirements
  - Aligned multi-antenna field trials and key performance evaluation
  - Push more antenna and equipment vendors to build a strong multi antenna products industry
- Deliverables
  - D1: multi-antenna key performance evaluations & trial
  - D2: multi-antenna tech solutions
  - D3: specifications of multi-antenna product series
- Progress since last meeting:
  - Finished the survey to GTI members
  - Invited 6 antenna vendors to join TF-MASS
  - Continue the research on solutions of compact antenna & co-site antenna
- Next steps：
  - Release research of antenna solutions
  - Start the antenna performance research and evaluation

3 main targets of TF:MASS

Have you meet the challenges in...?	What MASS will do...
Evaluation of different antenna tech:2/4/8path,esp. performance in real network	T1: -Key performance evaluation and aligned multi-antenna field trials -Recommendation in diff. scenarios
Deployments in complicated network environments: space limitation ,co-site, etc.	T2: -Solutions from global operating experience -Platform to share information
Antenna products selection: -How to find and choose antenna with good quality	T3: -Specification/guideline with widely antenna vendors participation

multi-antenna performance introduction and comparison

Basic performance test of 8 path antenna

- Interference suppression in cell edge: 39% gain due to beamforming(8path,TM2/7 comparison)
- Beamforming gain: 4~11 dB (depends on the environments)
- MIMO & Beamforming: mode adaption performs best

2/8 path antenna comparison

8 path antenna supporting TM2/3/7 performs better than 2 path antenna

- Coverage distance: 13% longer than 2 path antenna in down link and 21% longer in up link in average
- Coverage rate: both satisfied requirements (up to 95%)
- Throughput in Single UE: 48% gain in down link and 22% gain in up link in average VS. 2 path antenna; higher gain (downlink/Uplink:39%/45%) in cell edge

Cost comparison

- hardware cost: 8Vs.2=1.8
- Site num:8 VS.2=0.48(In 5Mbps,DL average coverage gain is 39% in cell edge to 2 ant.)
- 8 path antenna benefit the network deployment with fewer site amount req.

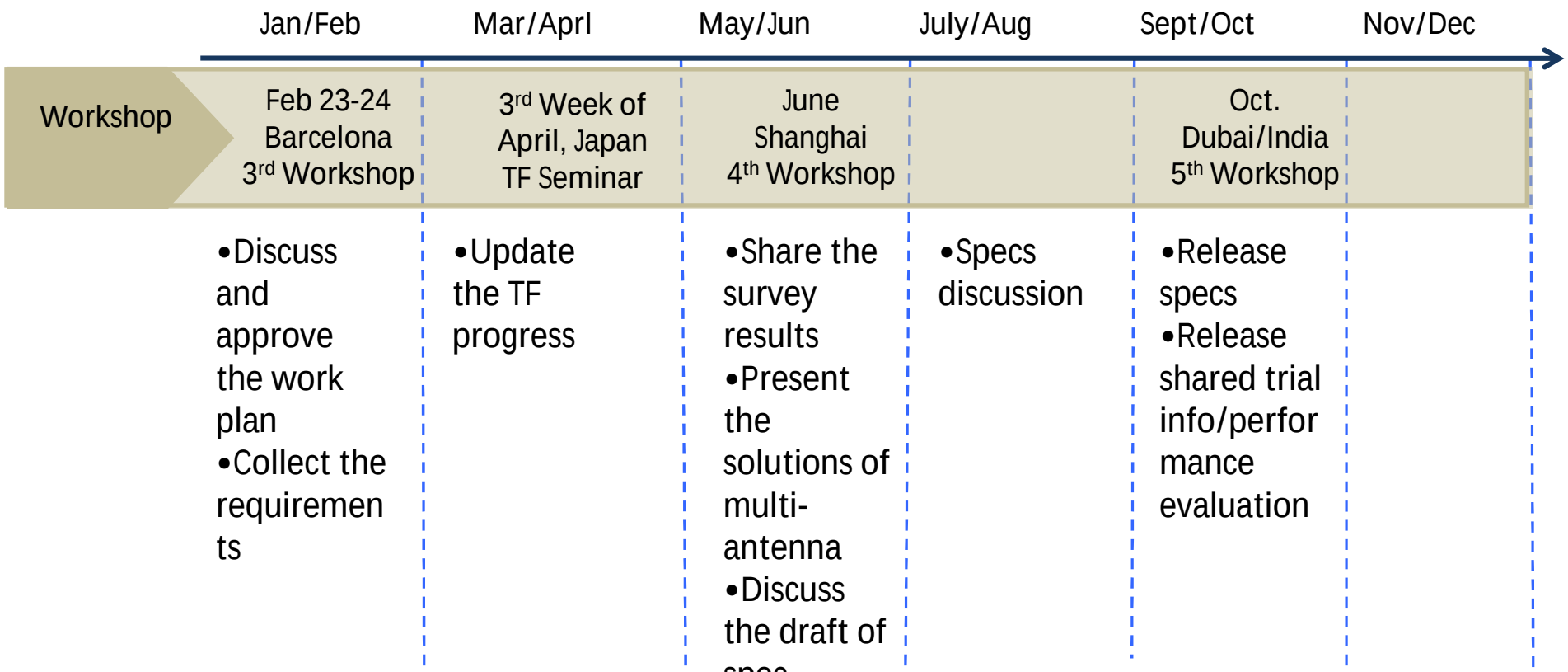
- 8 path antenna will be a good solution for primary outdoor coverage
- 2 path antenna will be appropriate for low cost/high speed coverage

Multi-antenna design requirement

- **Multi-band：**
  - Support super-wide band: 1800~2690MHz
  - 8 path dual-polar design (verified in 3G network)
- **Multi-mode：**
  - Support BF&MIMO（2×2、4×2、8×2）
  - Support 2G/3G/4G
- **Integrated:**
  - Less antenna connectors（up to 80% less）
  - Combined with RET tech
- **Compact design**
  - Easier installation
  - Much smaller size
  - Recommended solution in urban/dense urban area

Common specification for multi-antenna product will enlarge the antenna industry scale and reduce the product costs dramatically !

Work plan Update



Work plan -output

	Jan/Feb	Mar/Aprl	May/Jun	July/Aug	Sept/Oct	Nov/Dec
Main activities	Survey on Req.	Multi antenna evaluation(T1)	Multi antenna solutions(T2)	Spec discussion(T3)	Spec discussion(T3)	
Date	End of Feb	Mid April	June	Mid Aug	Oct	Nov
By:	Email/call	F2F meeting	F2Fmeeting /demonstration	Conf. call	F2F meeting	Conf. call
Output:	Survey results	D1:evluation& trial	D2:solutions		D3:specs	Final release