Base Station Subsystem Key Performance Indicators in EGPRS

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Introduction

- Until these days the packet data traffic has been low in 2G networks. Hence, there has been little need for packet data traffic optimization and monitoring.
- With EGPRS, operators are able to provide high-performance demanding services in 2G networks.
- Increased performance and new services attracts more users.
  => increased total packet data traffic in mobile networks.
- Increased packet data traffic in the traditional circuit switched network sets new requirements for network optimization and planning.
- New KPIs needs to be defined since packet data traffic cannot effectively be monitored with the same methods as circuit switched traffic.

Objectives and Methodology

Main objective:

- Examine which BSS KPIs in EGPRS should be used for network planning and monitoring, and how well they reflect the network performance and the end-user experience.

Secondary objectives:

- Provide a comprehensive view of the EGPRS functionality, and of the issues and problems related to monitoring and optimizing PS data networks.
- Provide a detailed description of the measurement setup that can be used as a guide in forthcoming measurements to test KPIs and new network features.

Methodology:

- Literature study of 3GPP standards, ETSI specifications and research articles.
- Measurements conducted in a test laboratory.

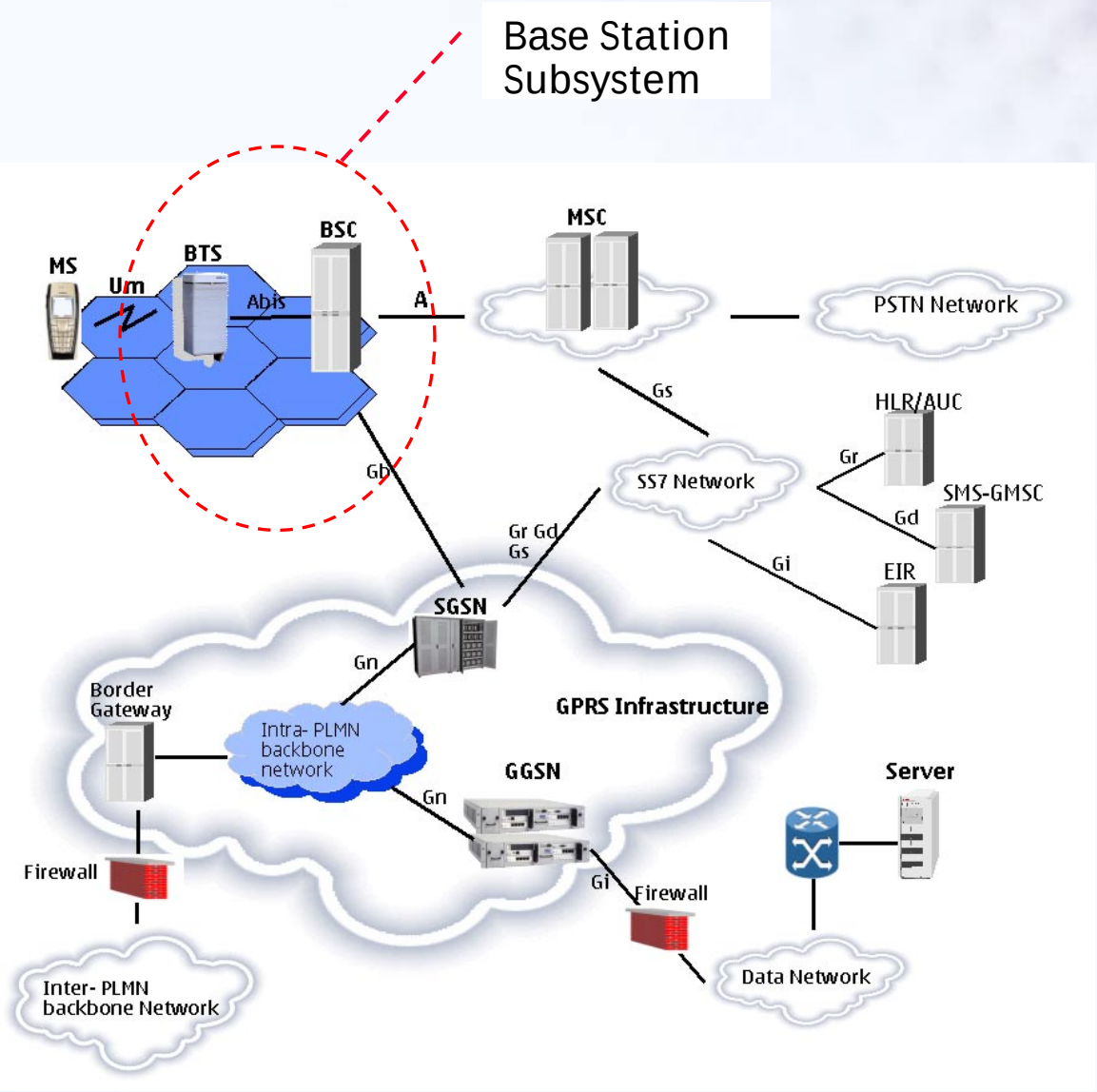
EGPRS Fundamentals

- EGPRS technology is an improved air interface to the GPRS technology.
- Enables 3 times higher data rates than GPRS due to new modulation technique.
- Max bit rate 59,2 kbit/s per Time Slot for EGPRS.
- => Theoretical maximum 59,2 kbit/s*8(time slots)= 473,6 kbit/s
- RTT ~200ms to ~700ms depending on phone model and network elements.

	coding scheme	modulation	RLC blks / radio block	FEC code rate	user bits / 20 ms	bit rate (bit/s)
GPRS	CS-1	GMSK	1	0.45	160	8,000
	CS-2		1	0.65	240	12,000
	CS-3		1	0.75	288	14,400
	CS-4		1	1	400	**20,000**
EGPRS	MCS-1		1	0.53	176	8,800
	MCS-2		1	0.66	224	11,200
	MCS-3		1	0.85	296	14,800
	MCS-4		1	1	352	17,600
	MCS-5	8-PSK	1	0.38	448	22,400
	MCS-6		1	0.49	592	29,600
	MCS-7		2	0.76	448 + 448	44,800
	MCS-8		2	0.92	544 + 544	54,400
	MCS-9		2	1	592 + 592	**59,200**

EGPRS Architecture

- EGPRS network is implemented into the GSM network.
- New network elements: SGSN, GGSN and BG



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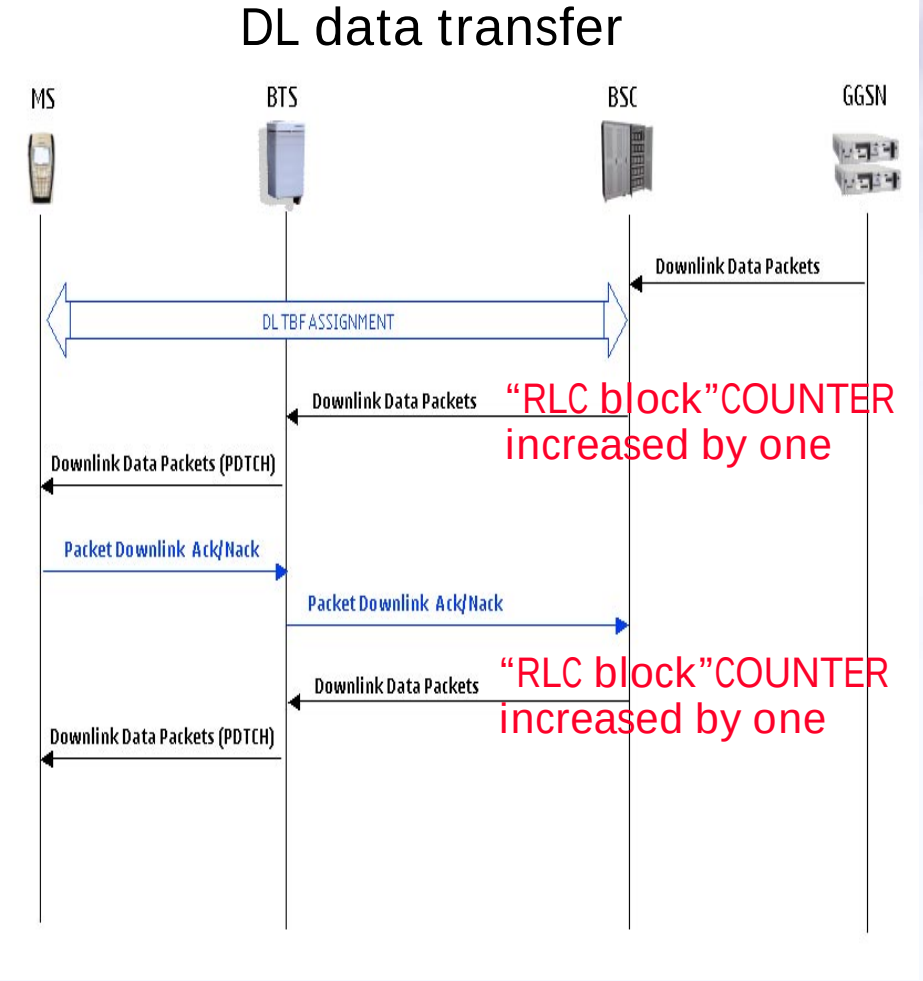
Counters and Key Performance Indicators (KPI)

- A counter triggers an event at the network.
  A counter is the most detailed level of information gained at the network.

  E.g. every time a RLC block is sent the “RLC block” counter is increased by one.
- KPIs are indicators that reflect some vital information concerning the network performance or the end-user experience (e.g. Throughput, total traffic, blocking).
  - The KPIs give higher level information than counters.
  - The KPIs are calculated from the counters.
- Properly defined KPIs helps to:
  - optimize the network
  - effectively locate trouble spots
  - predict future needs for investments and changes in the network.



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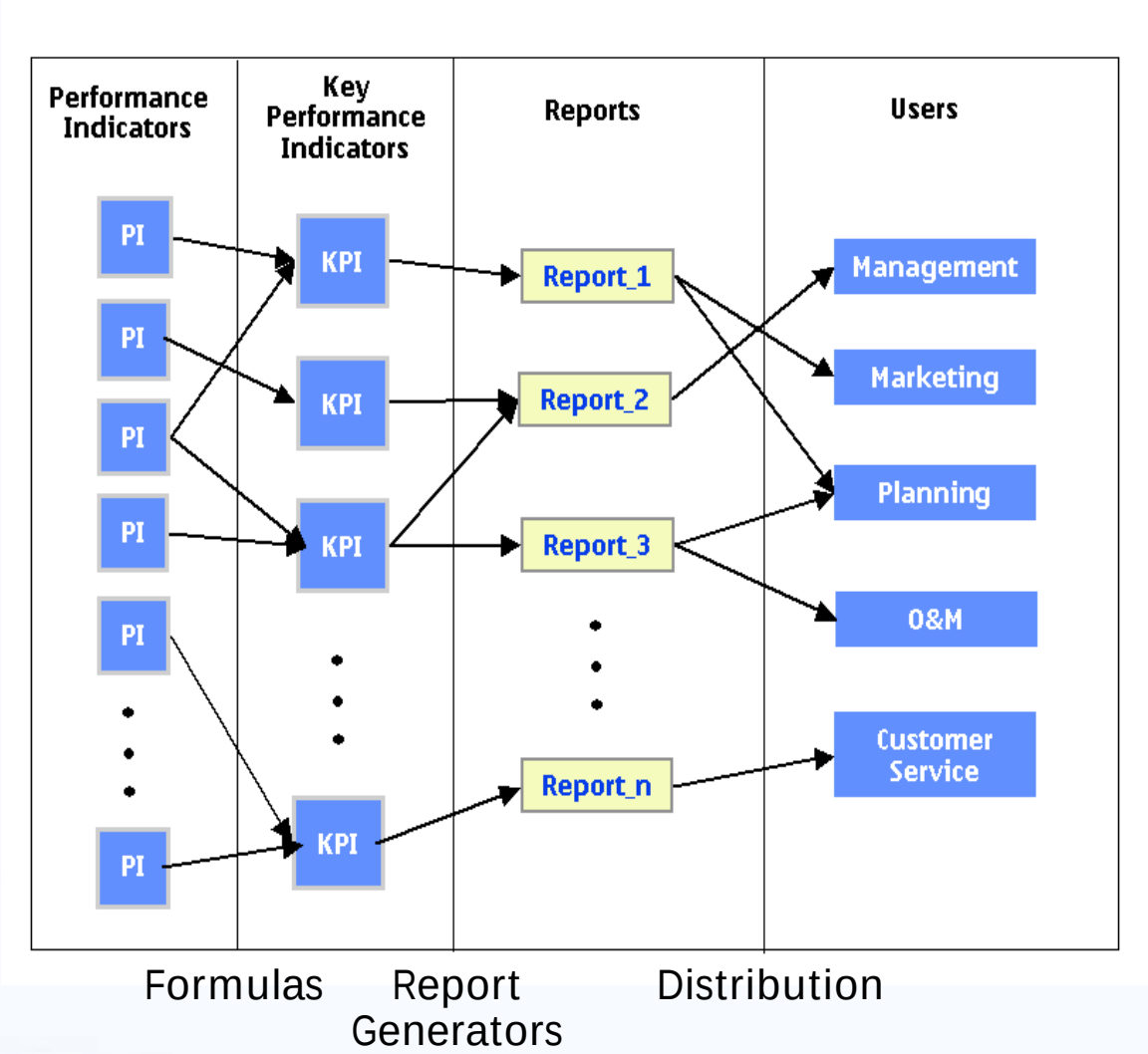
Key Performance Indicators (KPI)

- Network performance hard to interpret from counters as such, therefore a Performance Reporting method is needed.
- No single report can cover all information since different user groups are interested in different areas.

Performance Reporting



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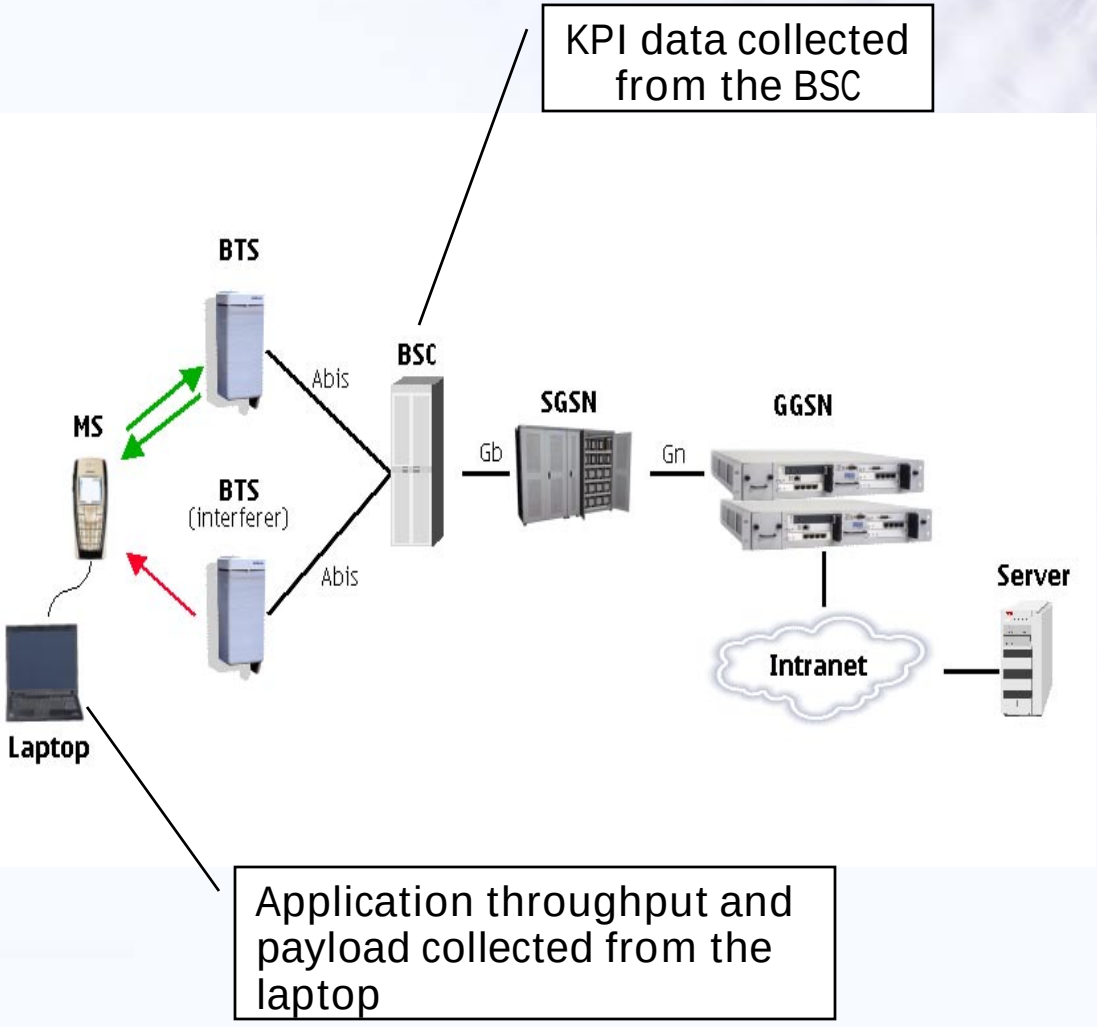
EGPRS Key Performance Indicators (KPI)

- **Traffic** KPIs reflect the network usage. I.e. how much data is transferred and how the resources are used.
- **Availability** KPIs show if the EGPRS network is available for PS traffic.
- **Accessibility** KPIs show if the service cannot be accessed due to some other problems than blocking or interference.
- **Quality** KPIs indicate the radio link quality and end-user experience.

KPI group	KPI
TRAFFIC	RLC Payload
	Packet Erlangs
AVAILABILITY	CCCH Blocking
	PDTCH Blocking
	PCU Congestion
	Abis Congestion
ACCESSIBILITY	GPRS/IMSI Attach Success Ratio
	PDP Context Success Ratio
QUALITY	TBF Properties
	RLC Retransmission Ratio
	MCS Selection
	RLC Throughput
	TBF Abnormal Releases

Measurement Setup

- Tests done in laboratory to have maximum control of the network.
- Air interface connections with cables to reduce unwanted interference.
- FTP, HTTP and UDP tests in different radio conditions (changing interference and fading simulation both in UL and DL).
- Results collected from the laptop compared against counter/KPI results collected from the network to verify the KPI behavior.
- 5 weeks of tests performed in total. Only a few results presented here.



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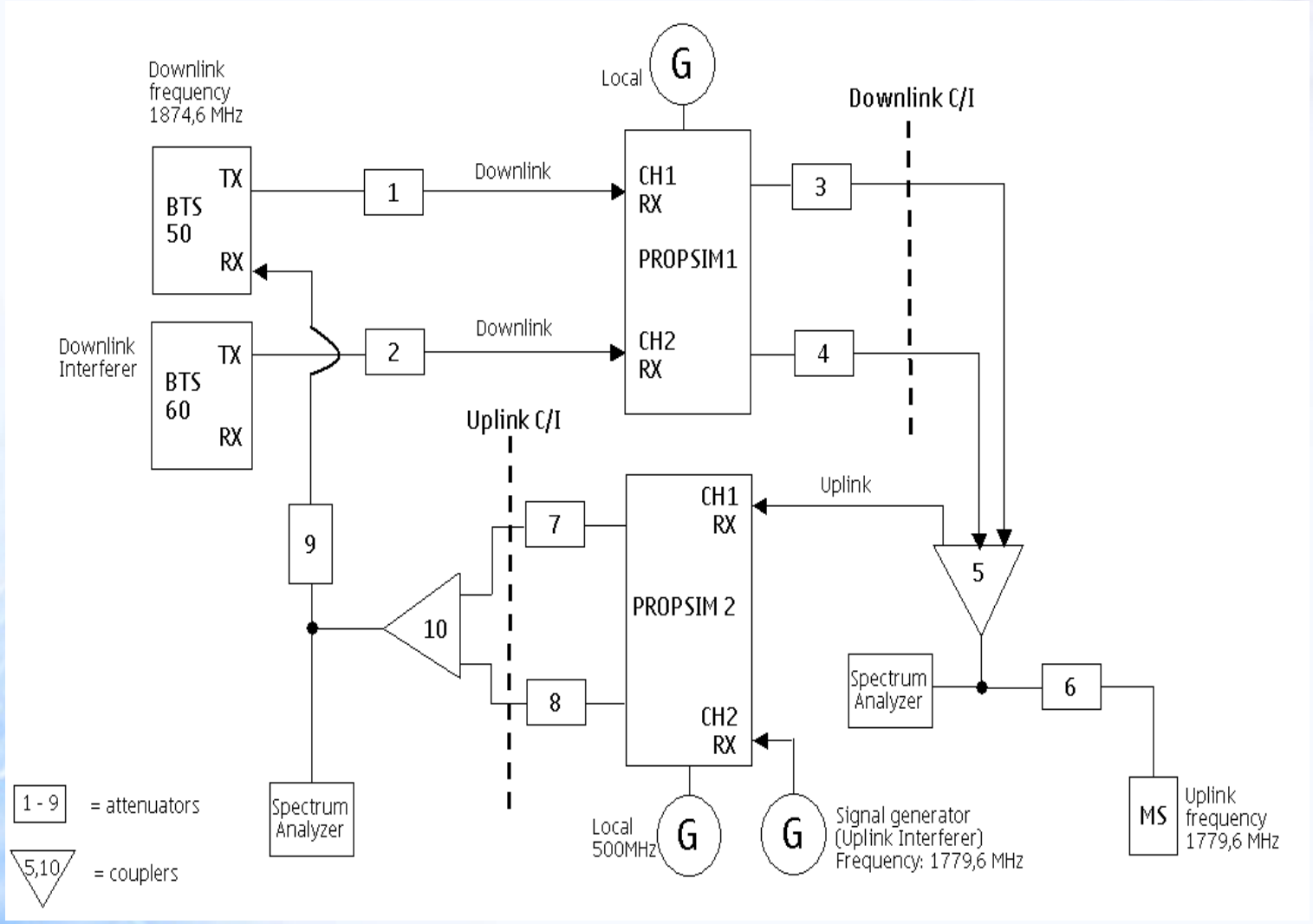
Air interface setup in measurements



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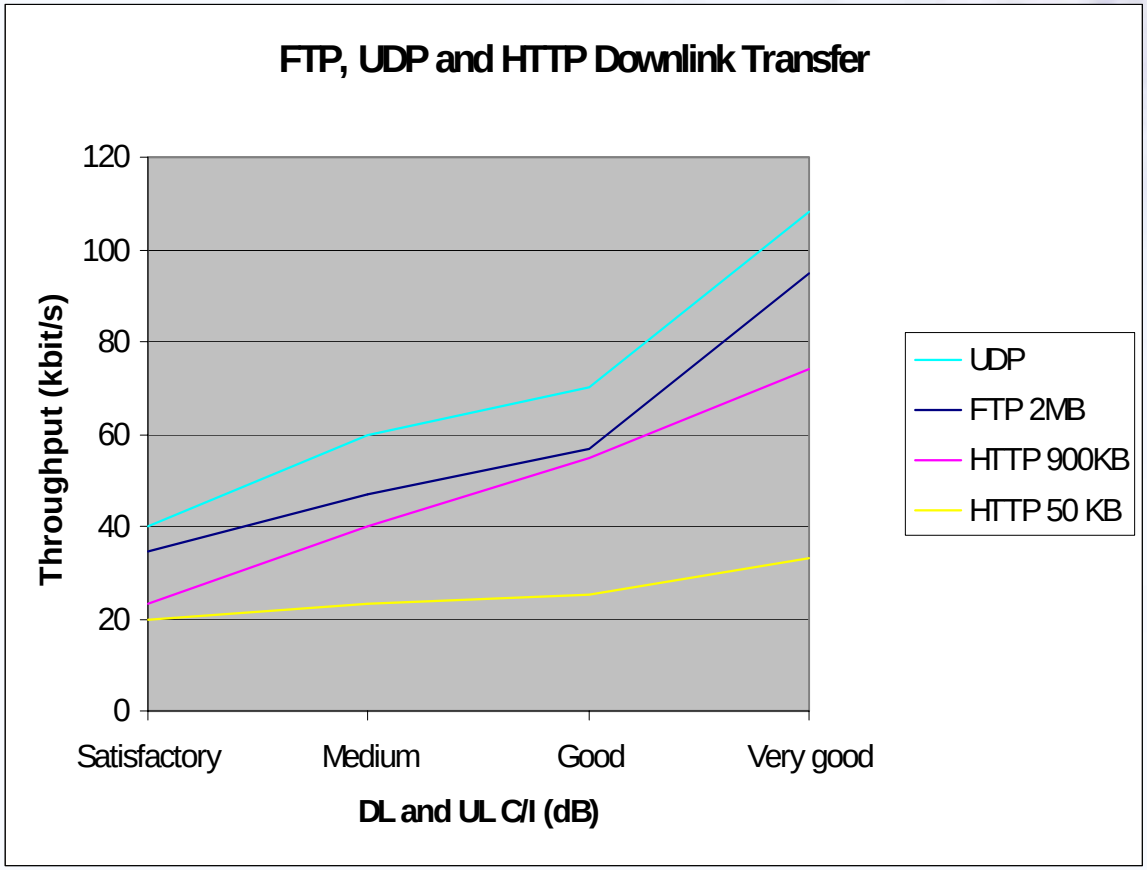
Measurement Results

- The main idea was to find BSS KPIs that would describe the network performance and the application throughput shown in the figure as accurately as possible
- All network counter/KPI values were compared against these user application throughput values.

Measurement results gained from the laptop



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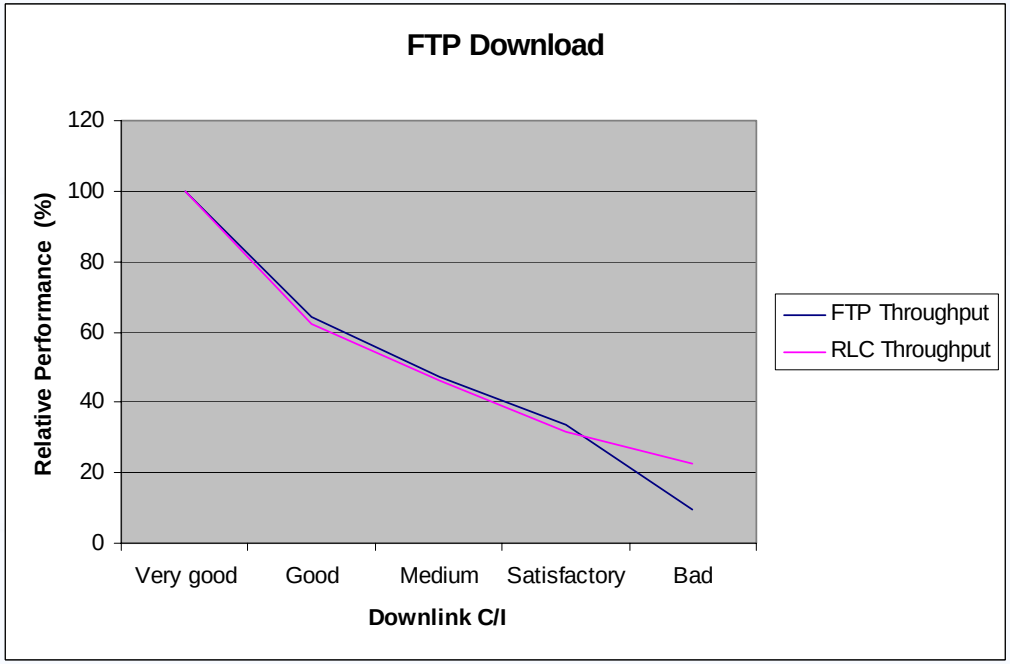
Measurement Results

- RLC throughput calculated from the network counters according to the formula.
- FTP throughput measured at the laptop.

$$RLC\_throughput(kbit/s) = \frac{\sum_{MCS-1}^{MCS-9} RLC\_data(kbit)}{total\_transmitted\_RLC\_blocks * 20ms}$$

C/I		FTP	RLC Throughput
Downlink	Uplink	Throughput	2 Time Slots
Very good	Very good	95 kbit/s	117 kbit/s
Good	Very good	61 kbit/s	72 kbit/s
Medium	Very good	45 kbit/s	54 kbit/s
Satisfactory	Very good	32 kbit/s	37 kbit/s
Bad	Very good	8.9 kbit/s	26 kbit/s

Relative Performance
(calculated from the values in the table)



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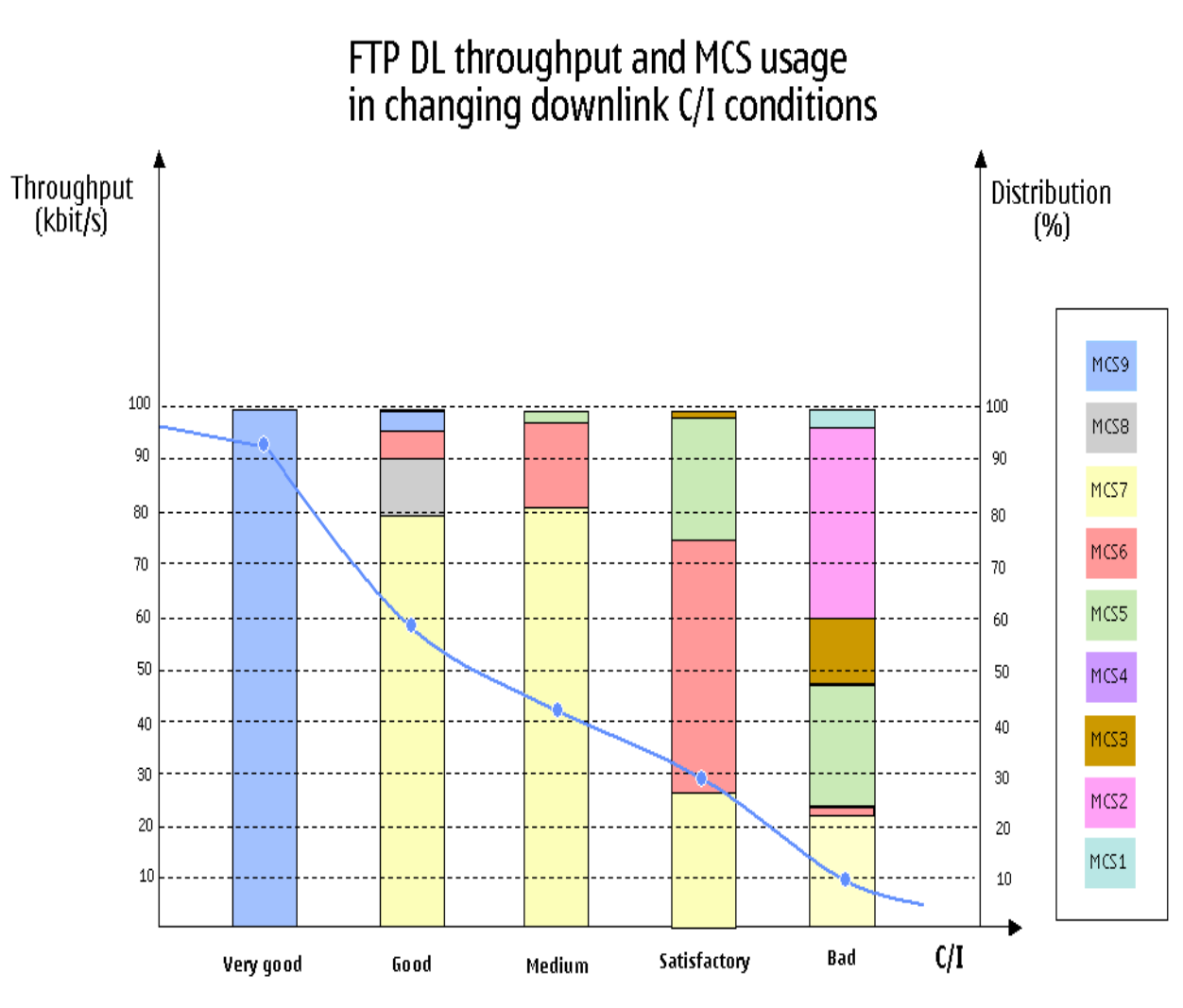
Measurement Results

- Based on the MCS distribution we may indicate the radio conditions and end-user experience.
- There are also other factors than radio conditions that can affect the MCS in use.
  - E.g. network congestion
  - EGPRS and GPRS users sharing a time slot.
- Therefore, multiple KPIs should be used while analyzing the radio link quality.



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Conclusions

- As long as the EGPRS network functions as a best-effort network it is challenging to monitor the individual end-user experience from the BSS.
  - E.g. retainability of a service is next to impossible to measure at the BSS.
- Service differentiation is needed to utilize the capacity of the EGPRS network to its full extent.
  - I.e. services should gain different amount of resources. Services with low requirements less resources than services with high requirements.

- The behavior of the BSS KPIs was described quite accurately via the measurements and the KPIs in this table can be used to effectively monitor and optimize the network.
- Assumptions about the quality should not solely be made on one quality KPI.

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Questions?

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