THE ERICSSON SGSN-MME
-
OVER A DECADE OF ERLANG SUCCESS

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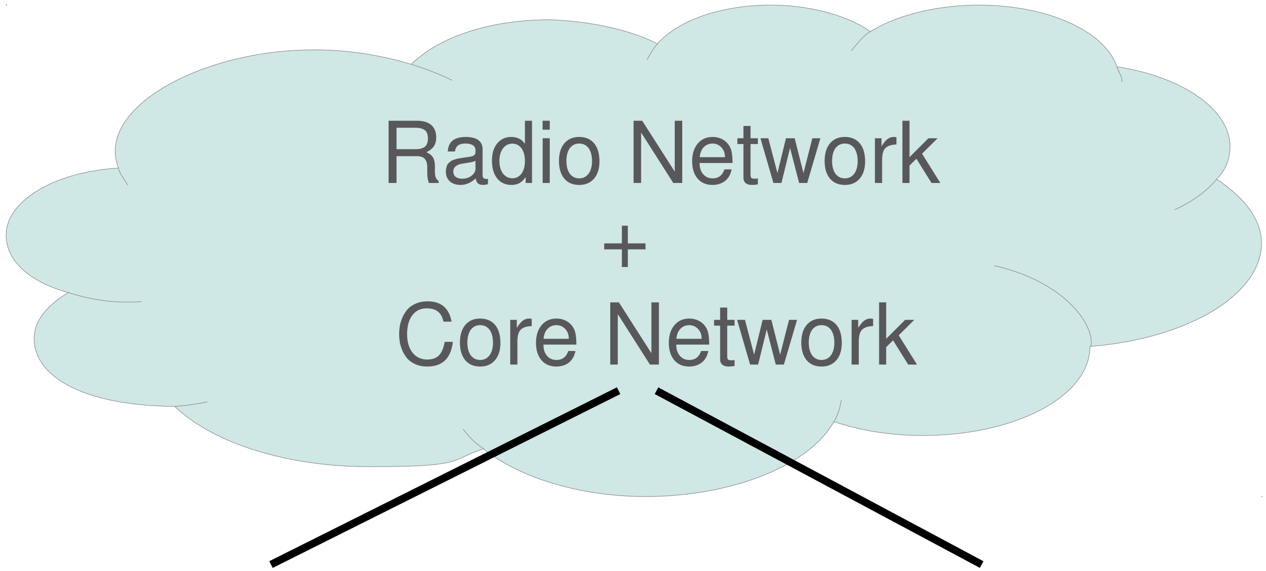
OUTLINE

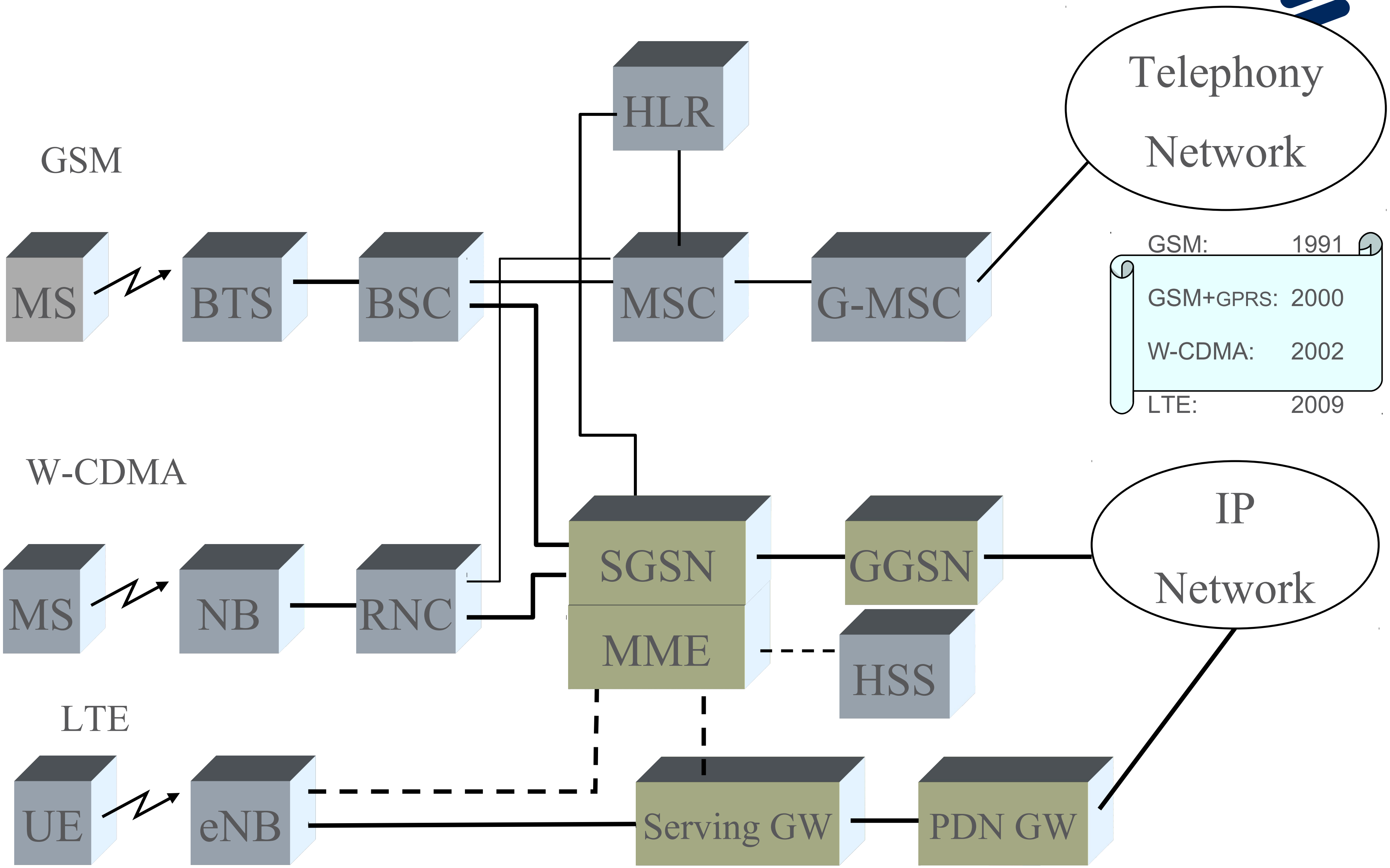
- Mobile Telecommunications Networks
- SGSN-MME
- Erlang
- Fault Tolerance
- Capacity & Overload
- Multicore & Scalability
- Large scale software development

MOBILE TELEPHONY



Circuit Switched	Packet Switched
Old	New
Voice	IP
SMS	WWW, Email, etc.
	Voice-over-IP

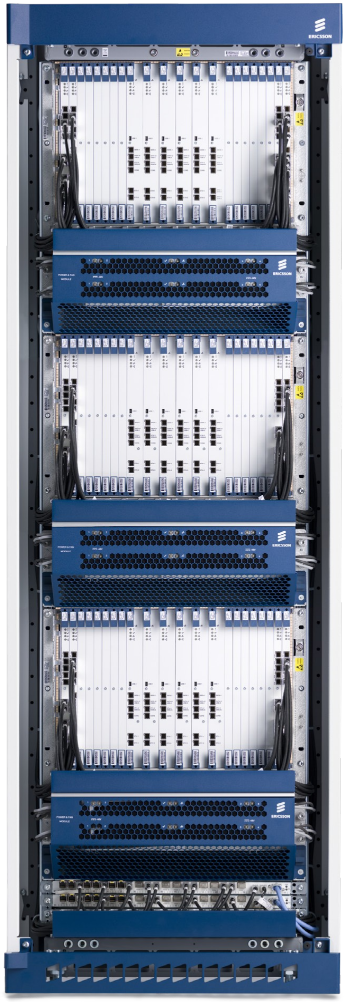
3GPP MOBILE SYSTEMS – GSM, W-CDMA & LTE



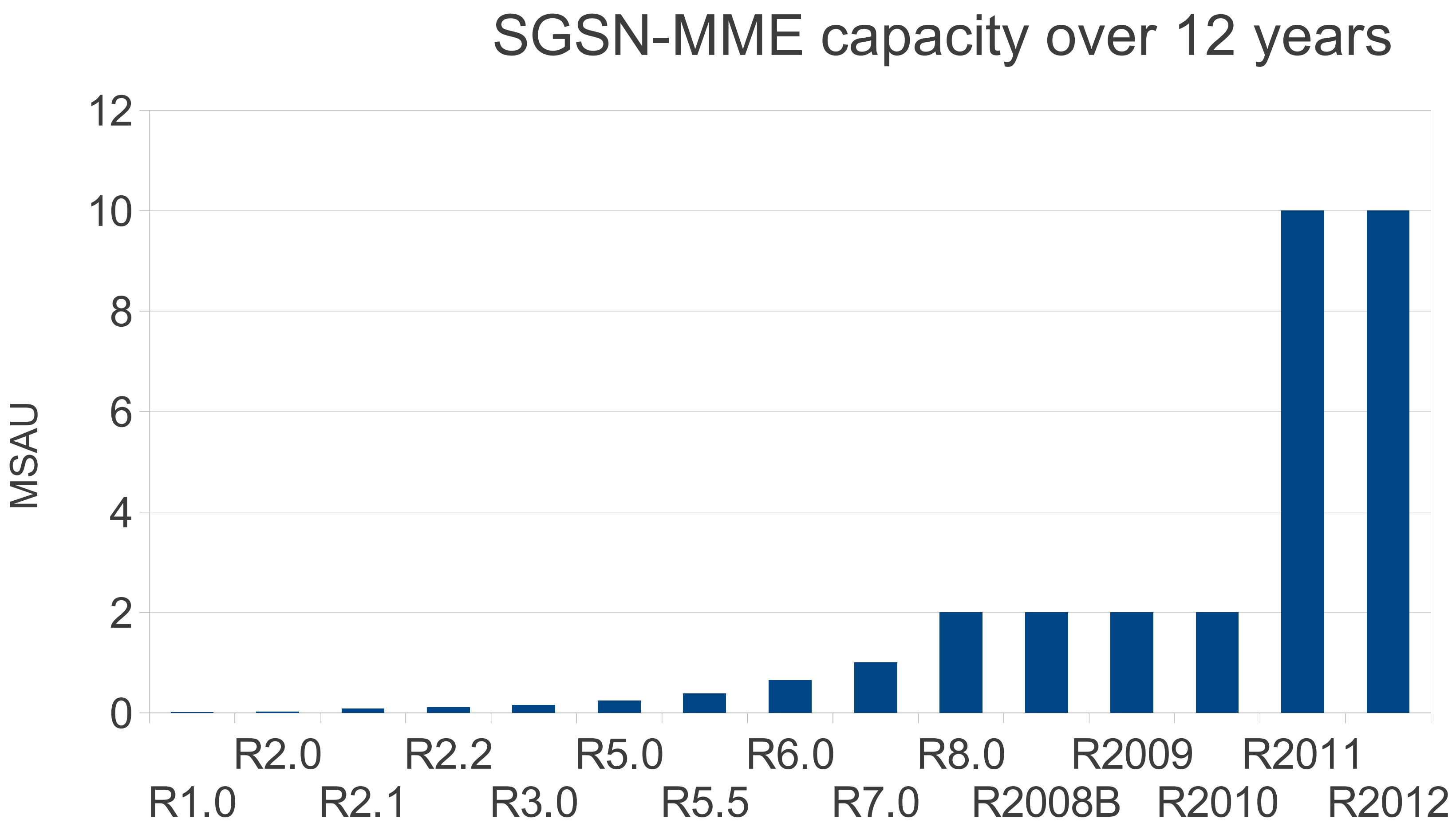
SGSN-MME HARDWARE

- 3 magazine cabinet
- Each general board:
  - recent Intel Xeon multicore
  - lots of RAM
- Special purpose HW:
  - switches, routing HW
  - FPGAs
  - physical interfaces
- Everything redundant

- Price: high!



CAPACITY

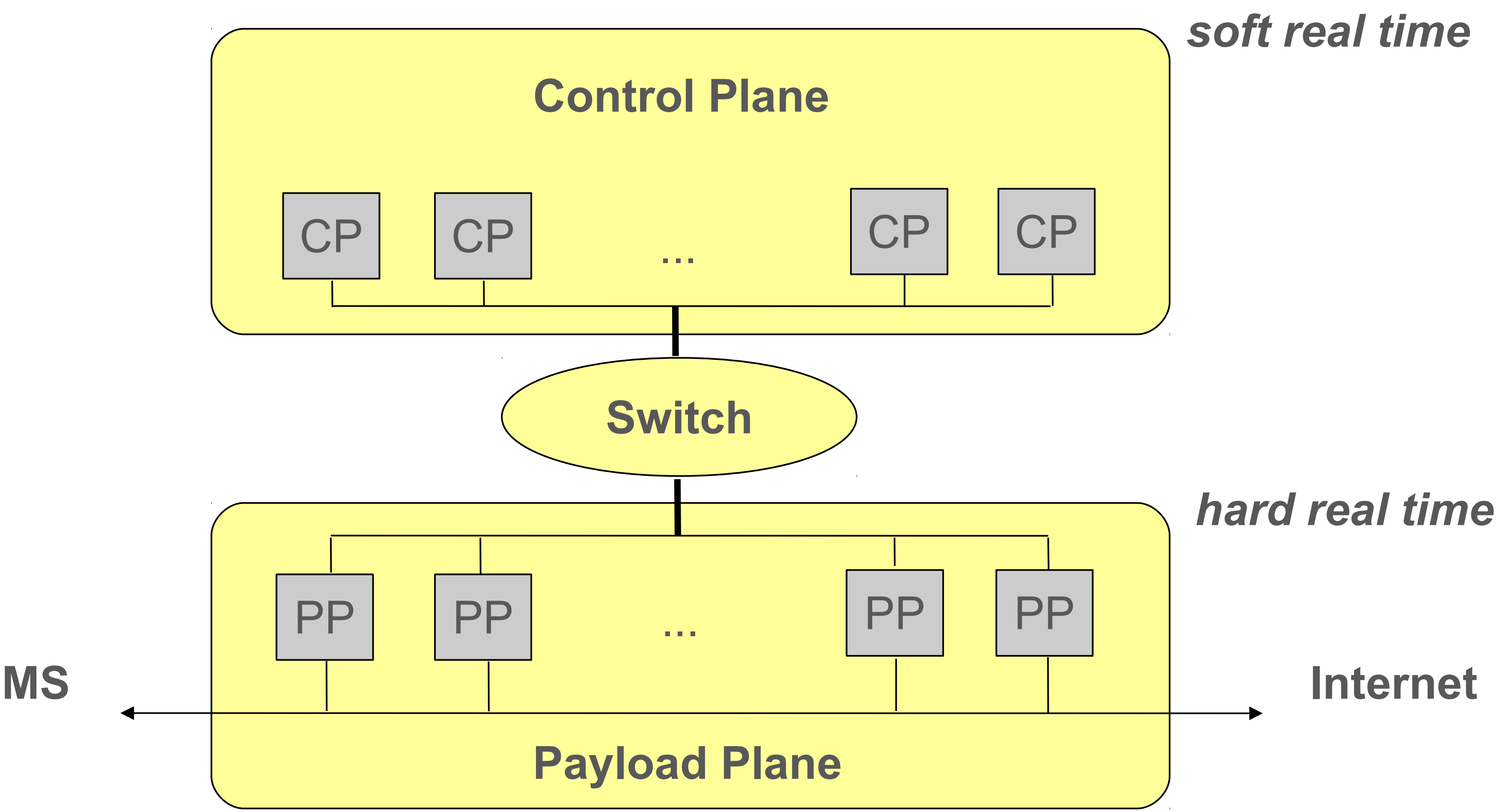

SGSN-MME capacity over 12 years
MSAU
12
10
8
6
4
2
0
R1.0
R2.0
R2.1
R2.2
R3.0
R5.0
R5.5
R6.0
R7.0
R8.0
R2008B
R2009
R2010
R2011
R2012

REQUIREMENTS

- Control Signalling
  - Between network and Mobile Phone (MS)
  - Invisible to user
  - Called “Signalling”

- User Traffic
  - Normal IP packets between MS and Internet
  - Requested and seen by user
  - Called “Payload”

ARCHITECTURE



WHY ERLANG?

- High level language
- Built-in concurrency
- Built-in distribution
- Built-in fault tolerance
- Runtime code replacement

Exactly what is needed to build a robust control plane!

FAULT TOLERANCE

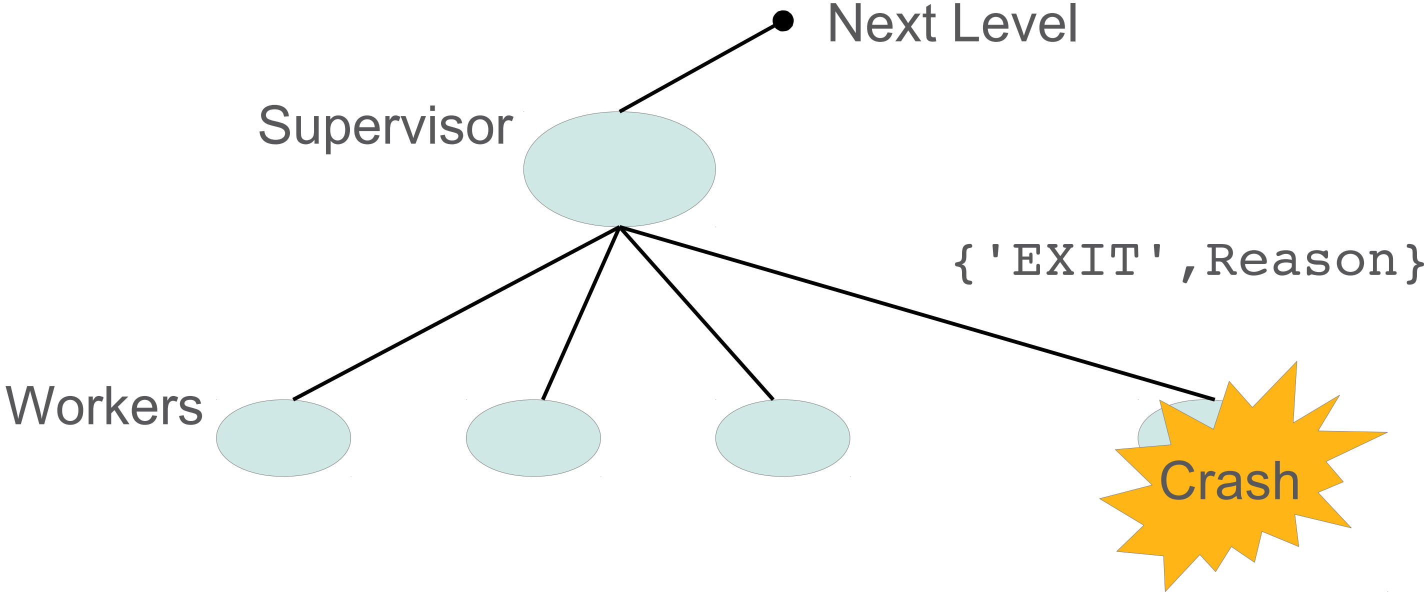
- ISP – In Service Performance
- SGSN-MME must never be out of service! (→ 99.9999%)

- Hardware fault tolerance ("easy")
  - Detect faulty HW
  - Take it out of service
- Software fault tolerance ("hard"!)
  - Many more degrees of freedom
  - Not so easy to take SW out of service

EXAMPLE SW FAULT TOLERANCE

- System principle: one Erlang process serves one MS
- SW error in SGSN-MME (“MS handling code”) leads to:
  - restart of process
  - all data stored for MS removed from SGSN-MME
  - MS is forced to restart signalling from the beginning
  - ISP effect: short service outage for this MS
  - no other MS:es affected

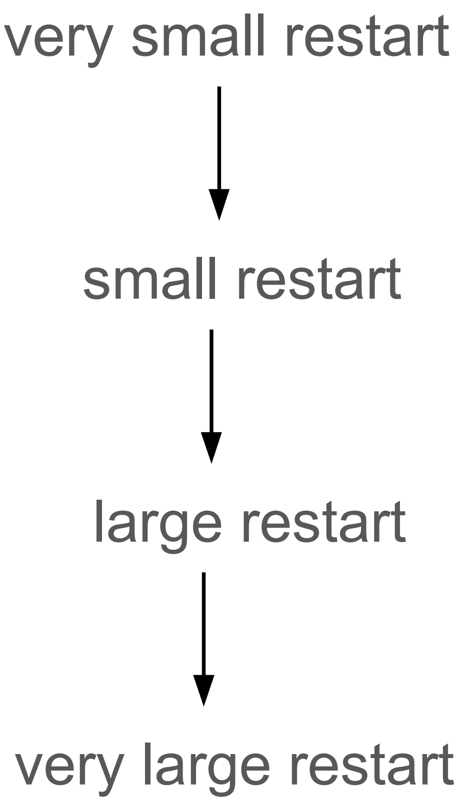
SUPERVISION



› Do not try to “handle errors”
› Crash instead!
› Offensive programming
› Error could be in MS or in SGSN-MME:
  – failure to follow standard
  – internal state messed up
  – packet corrupt

SW RECOVERY STRATEGY

- Restart Levels
- Escalation Hierarchy
- Kill more and more processes
- Remove more and more stored data
- Time vs. effect?



BUGS IN ERLANG

- If the SGSN-MME fails our customers do not care who introduced the bug
- We must be able to handle Erlang/OTP bugs

- Same basic recovery mechanisms are used!
- Special rule for this case: “kill entire Erlang BEAM”
- SGSN-MME includes lots of “monitoring” of internal state
- Try to identify Erlang BEAMs that misbehave

OVERLOAD PROTECTION

- The SGSN-MME must never “stop to respond”
- CPU load must be kept below 100% (unreliable otherwise)
- High load can be:
  - user initiated
  - network faults leading to excessive signalling
  - denial of service attacks

- Solution: drop some packets (selectively)
- Natural in Erlang message passing paradigm!
- Difficult in practice: takes years of experience from live networks to get right

MULTICORE & SCALABILITY

- Erlang in theory: “scalability for free”
- In practice: not for free, but quite good
- SGSN-MME workload “one process per MS” is almost the perfect fit!
- But very hard to avoid system level bottlenecks
  - dispatcher processes
  - ETS tables
  - lock contention
  - communication
- Multicore profiling at high load is very hard!

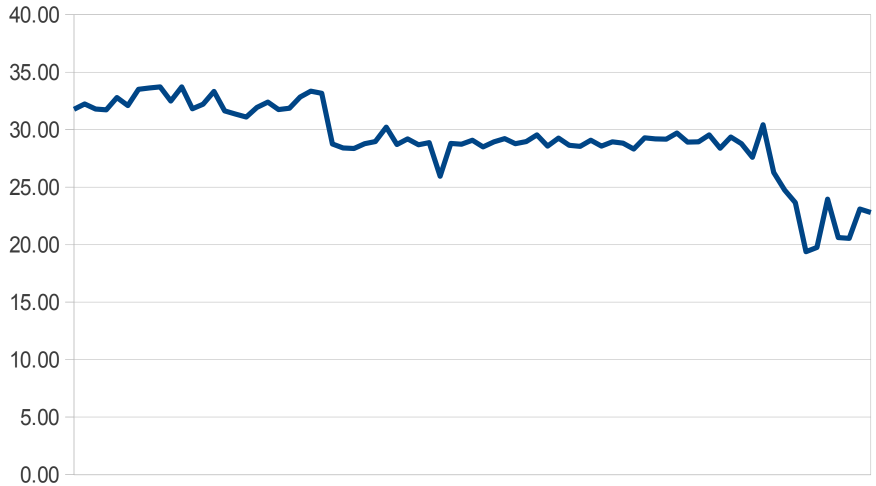
OTP R14 → R15

- HW is Intel Xeon, 8 schedulers
- Test is "SGSN-MME traffic model"
  - simulating a number of MS doing "normal things"

- multicore scheduler improvements
- half word machine
- ASN.1 decoding NIF
- "nospin" patch

→

- CPU load R14: ~30%
- CPU load R15: ~20%



RUNTIME CODE CHANGE

- Live patching is a must
- The less disturbance the better
- Erlang built in support is good but far from enough

- A whole system level strategy needs to be built on top
- Must include “operational and usability aspects”
- Procedure should be automatic – humans make mistakes!

- A single failed patching means it will be harder to convince customer to install next patch!

FUNCTIONAL PROGRAMMING?

- SGSN-MME technical standards (GPRS) are extremely complex
- We invented lots of abstractions and design patterns
- Let programmer concentrate on GPRS – not on programming details
- Functional parts of Erlang make this easier
- Result is a kind of “Telecom/GPRS domain specific language” embedded within Erlang

- Works very well!
- Hard for some programmers to accept that they are not in full control

LARGE SCALE DEVELOPMENT

- Several hundred people – almost 15 years
- In the beginning many different sites – all over the world
- Now mainly on two sites

- Difficulties:
  - manage the source code: lots of parallel activities
  - merging and integration activities take much resources
  - how to keep good quality of “very old code”?
  - hard to do some fundamental changes – too much code depends
  - ways of working constantly improving
  - from RUP to cross functional teams and lean

CONCLUSIONS

- Erlang is more or less “perfect” for the control plane in a system like this
- Erlang/OTP is very good now – many bugs historically
- Tools can be improved, eg high load profiling
- Many telecom nodes have similar requirements – few use Erlang

- Final words:
  - Erlang is fun to work with!
  - How long can this amazing system continue to evolve?

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