INSIGHTS ON THE CONFIGURATION AND PERFORMANCES OF SOME/IP SERVICE DISCOVERY

Jan R. SEYLER, Daimler A.G, Mercedes Cars
Nicolas NAVET, University of Luxembourg
Loïc FEJOZ, RealTime-at-Work (RTaW)

Outline

- What is SOME/IP and SOME/IP SD
- Protocol description SOME/IP – Service Discovery
- Calculating the service subscription latencies in SOME/IP-SD
- Sensitivity analysis: parameters with the most impact?

Use-cases for Ethernet in vehicles

Infotainment

- Synchronous traffic
- Mixed audio and video data
- MOST like

Cameras

- High data rates
- Continuous streaming
- LVDS like

Diag. & flashing

- Interfacing to external tools
- High throughput needed

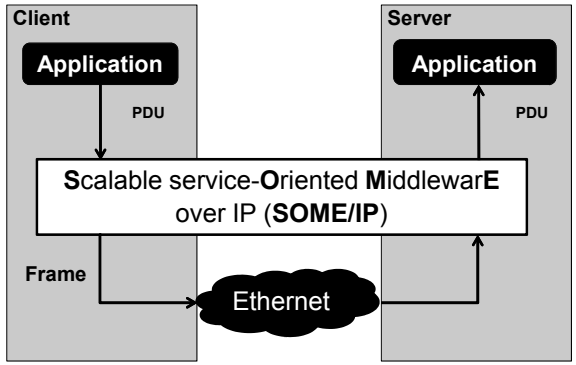
Control functions ADAS

- Time-sensitive communication
- Small and large data payload
- Cover CAN / Flexray use cases and more

TWISTED-PAIR

What is SOME/IP? In-vehicle Service Oriented Communication

Service-oriented instead of signal-oriented communication



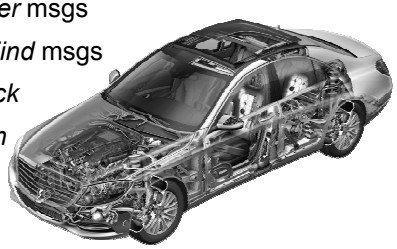
More flexibility & dynamicity, such as adding services or migrating services at run-time

- ✓ AUTOSAR and GENIVI compatible middleware on top of IP
- ✓ Benefits of Ethernet higher bandwidth and frame size – limit use of broadcast
- ✓ **Services: RPC, event notification**
- ✓ Defines the on-wire format (structured data)
- ✓ The network addresses of Clients (service user) and Servers (service provider) are not statically defined.

Overview of SOME/IP SD

SOME/IP SD: **service discovery** and connection management

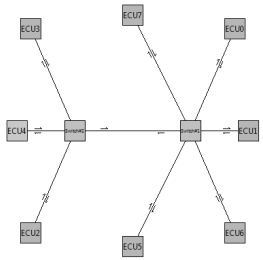
- ✓ Services are advertized by broadcast *Offer* msgs
- ✓ Clients looks for services via broadcast *Find* msgs
- ✓ Once a service is located: *Subscribe – Ack*
- ✓ 2 modes for a client : *Request* and *Listen*
- ✓ 2 modes for a service: *Offer* and *Silent*



Objective: find the right tradeoff between subscription latency and SOME/IP SD overhead

What we can foresee about the use of SOME/IP

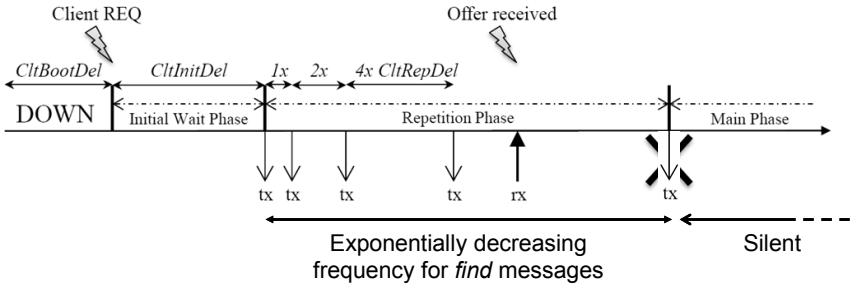
1. Switched Ethernet: a few switches and a few tens of nodes
2. Frame latencies are less than a few ms
3. Time-sensitive traffic, in addition to SOME/IP and SOME/IP SD
4. Nodes are not synchronized on startup



5. A node may host several clients of distinct services and offer several services
6. The total number of services range from a few tens to a few hundreds
7. A node request a fraction of the services offered (at most a few tens)
8. A node may require to subscribe to services before it can offer its own services
9. Services might not be used and offered all the time: mode changes, partial networking

SOME/IP SD – client's side

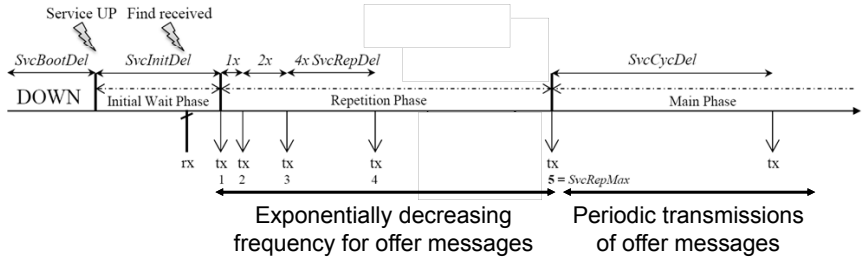
- ✓ A client looks for the services it needs through broadcasted *find* messages
- ✓ Initial Wait Phase (IWP) is entered upon the request of the applicative layer – time spent in IWP is chosen at random in an interval



- ✓ *offer* messages from server are answered asap – even during IWP - and client goes to Main Phase

SOME/IP SD – server's side

- ✓ A service broadcast *offer* messages on the network to notify the availability of a service
- ✓ Initial Wait Phase (IWP) is entered upon the request of the applicative layer – time spent in IWP is chosen at random in an interval
- ✓ *Find* messages received in IWP are ignored



- ✓ Answer to *find* messages from clients is done after a time chosen at random in an interval

Factors impacting the client subscription latency

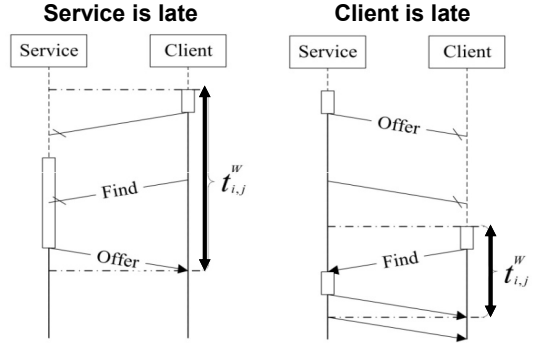
1. Time at which the service become first available – if the service is late, the client will register on the first *offer* message sent at the end of the initial wait phase
2. Functioning mode of services and clients: Listen/Silent is worst for latency
3. SOME/IP SD protocol parameters, eg.:
   - ✓ Initial Wait Phase for client and server
   - ✓ ClientRepDelay and CltRepMax
   - ✓ ServerRepDelay and SrvRepMax
   - ✓ The time for a service to answer a *find* message
   - ✓ SrvCycleDelay in the main phase
4. The communication delay (ranges from us to ms)

There are no guidelines on how to configure SOME/IP SD

Scope of the study: study impact of SOME/IP SD parameters in subscription latency

Subscription latency when both service and client are in request mode

- ✓ Subscription latency: time from client is operational (leaves "Down") until it receives an *offer* – subscribe and ack messages afterwards not counted



Registering on the first *offer* message

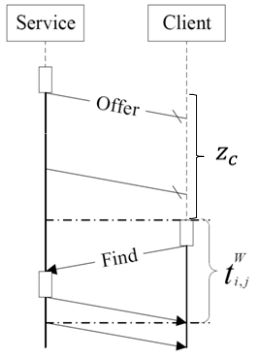
Registering on *offer* or *find* messages

Existing work : computing the worst-case subscription latency

"Formal Analysis of the Startup Delay of SOME/IP Service Discovery", DATE 2015, Grenoble, France, March 9-13, 2015.

Calculation of SOME/IP startup delay

- ✓ A set of formulas has been derived to calculate the maximum waiting time of a client in any possible configuration – example:



1. Find X such that $z_c - t_c \leq \sum_{k=0}^{X} 2^k \cdot SvcRepDel$

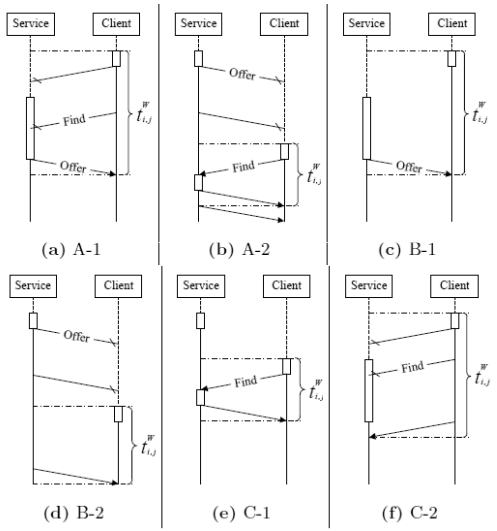
   $\rightarrow X = \left\lceil \log_2 \left(\frac{z_c - t_c}{SvcRepDel} + 1 \right) \right\rceil - 1$

2. Calculate t^W

$$t^W = \min \begin{Bmatrix} (2^{X+1} - 1) SvcRepDel + t_c - z_c \\ CltInitDel + 2t_c + SvcAnsDel \end{Bmatrix}$$

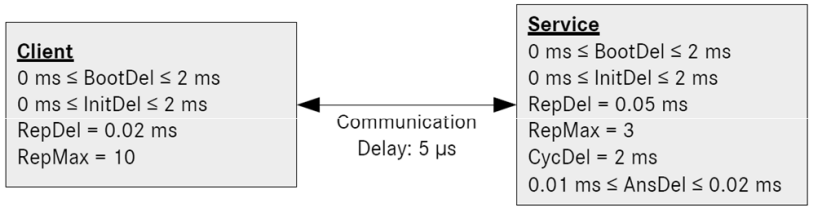
No pessimism
the worst-case scenario is returned

All possible configurations wrt to client and server startup times and request/silent mode



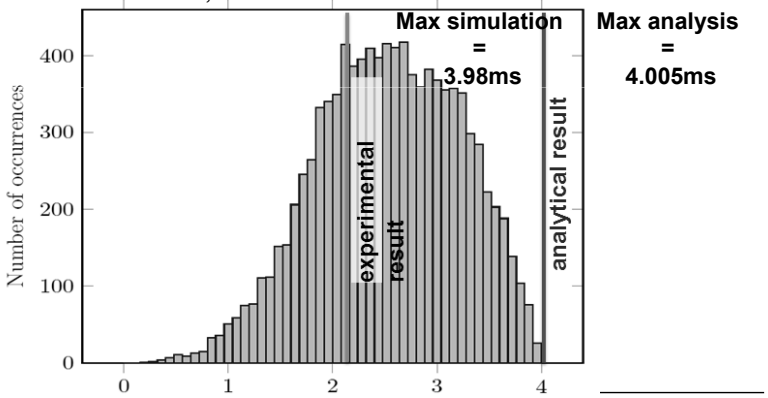
- ✓ **A-1:** OM for service, RM for client Service is late
- ✓ **A-2:** OM for service , RM for client Client is late
- ✓ **B-1:** OM for service, LM for client service is late
- ✓ **B-2:** OM for service, LM for client client is late
- ✓ **C-1:** SM for service, RM for client client is late
- ✓ **C-2:** SM for service, RM for client service is late

Experimental setup: one service and one client



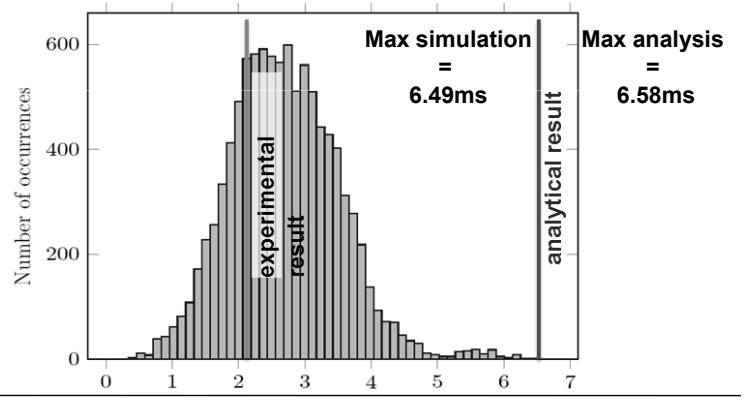
Experiment 1 - client in *silent* mode – server in *offer* mode

- ✓ Simulation in *CPAL* language - 10 000 run – fixed comm. latency
- ✓ *Worst-case situation here:*
  - *SvcBootDelay = 2ms, SvcInitDel =2ms,*
  - *CltBootDel= 0ms, CltInitDel=0ms*



Experiment 2 - client in *find* mode and server in *silent* mode

- ✓ Simulation in *CPAL* language - 10 000 run – fixed comm. latency
- ✓ *Worst-case situation:*
  - *SvcBootDelay = 2ms, SvcInitiDel =2ms,*
  - *CltBootDel= 0ms, CltInitDel=1.45ms*

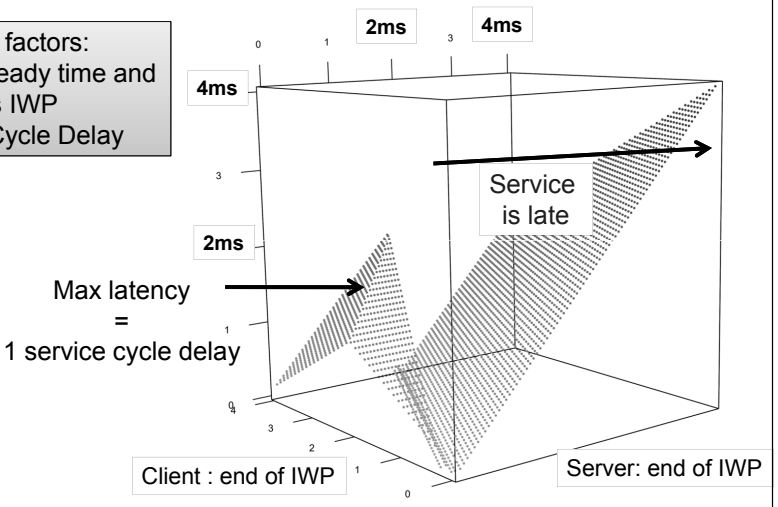


Sensitivity Analysis of SOME/IP SD parameters

Same setup as before with
Server in *Offe*r mode
Client in *Request* mode

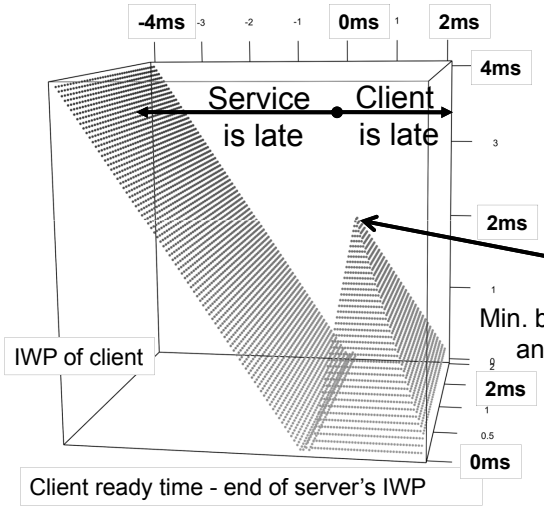
Worst-case subscription latency for varying values of the end of the Initial Wait Phase (IWP) of server and Client

Main factors:
- Service ready time and length of its IWP
- Service Cycle Delay



Worst-case subscription latency for different startup offsets between client and service, and varying length of client's IWP

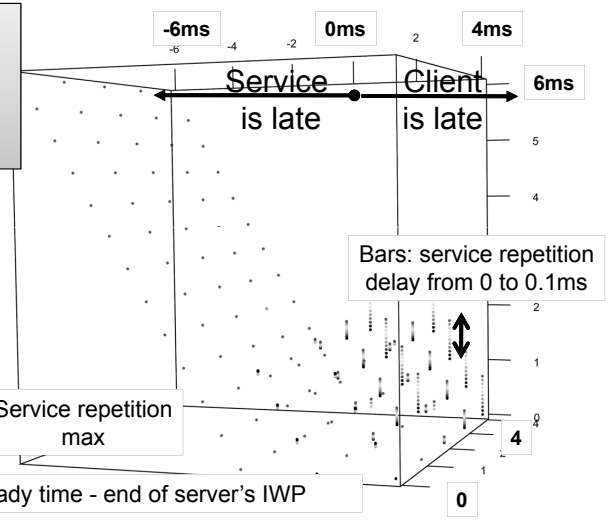
Reducing length of client IWP is efficient when service is operational before client



Max latency = Min. between service cycle time and length of client's IWP

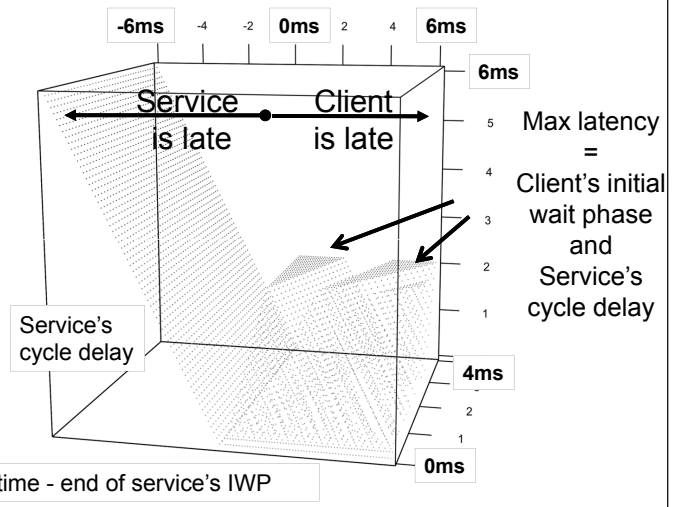
Influence of the service's parameter in repetition mode on the worst-case subscription latency for varying startup offsets between client and service

Increasing Service repetition max and reducing the repetition delay helps to a limited extent



Influence of the service's cycle delay on worst-case subscription latency for varying startup offsets between client and service

Service's cycle delay less than client's IWP reduces subscription delay



Concluding remarks

- ✓ SOME/IP SD's dynamic well understood and analyzed, toolset available – rationale of some design choices unclear
- ✓ There are step-effects but performance are acceptable for large range of parameters if timing constraints are not too short
- ✓ Main factors that influence the subscription latency:
  - Ready time of the services and length of their Initial Wait Phase
  - Service's cycle delay
- ✓ Ongoing experiments with timing accurate simulation of communication latencies (CPAL model on top of RTaW-Pegase) → network latency can be significant (>1ms) and parameters should be chosen accordingly
- ✓ Further progresses require case-studies

Thank you