

Erlang Solutions Ltd.

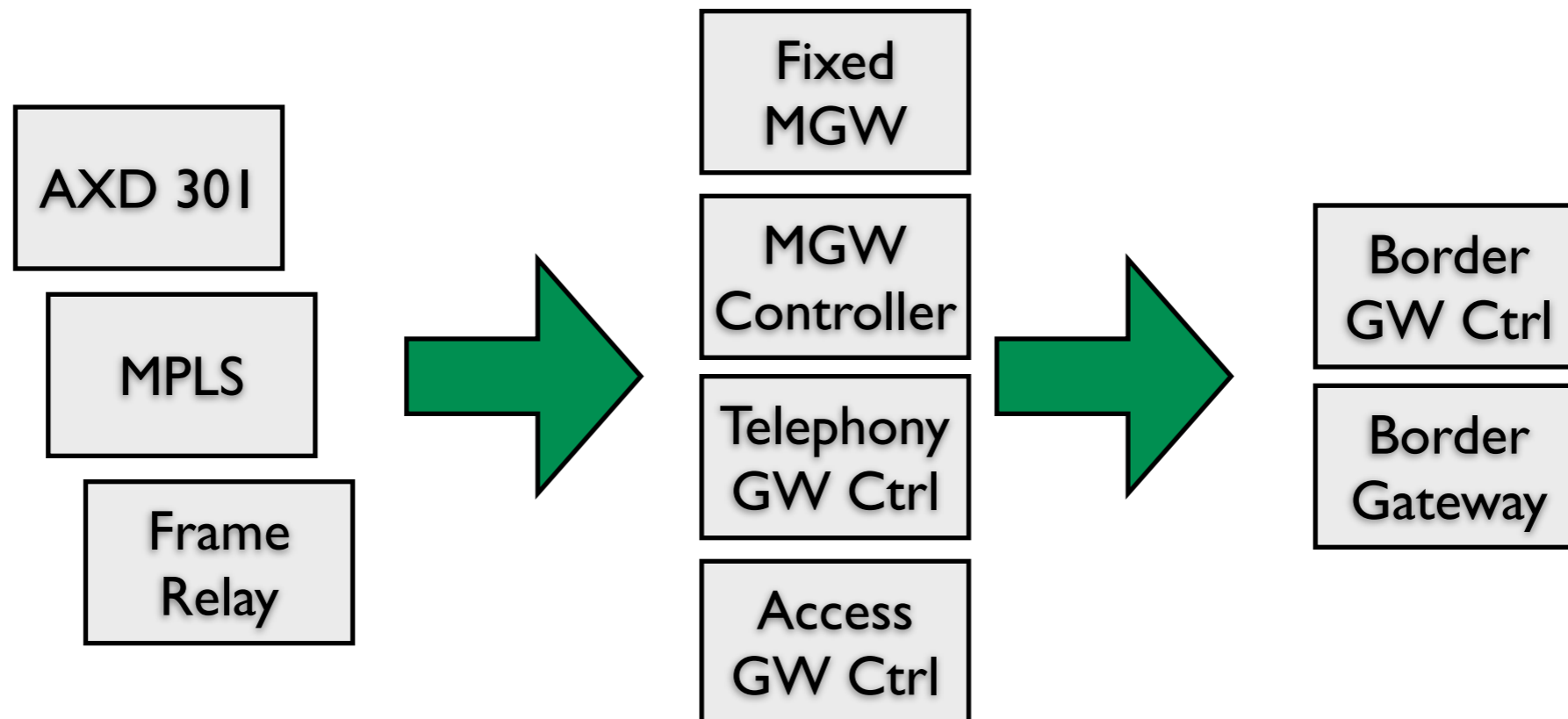
# The Erlang/OTP Diameter Stack

Ulf Wiger, CTO Erlang Solutions Ltd



# About me

- 13 years at Ericsson
- Chief designer of a number of Erlang-based products
- CTO, Erlang Solutions since 2009



# Background

- **Ericsson Session Border Gateway Controller**
  - (essentially a multimedia pin-hole firewall)
  - (re-)written in Erlang in one year
- **Diameter stack needed for**
  - Location lookup
  - Resource reservation
  - Billing
- **Initial idea was to buy an existing stack**

# Shopping around

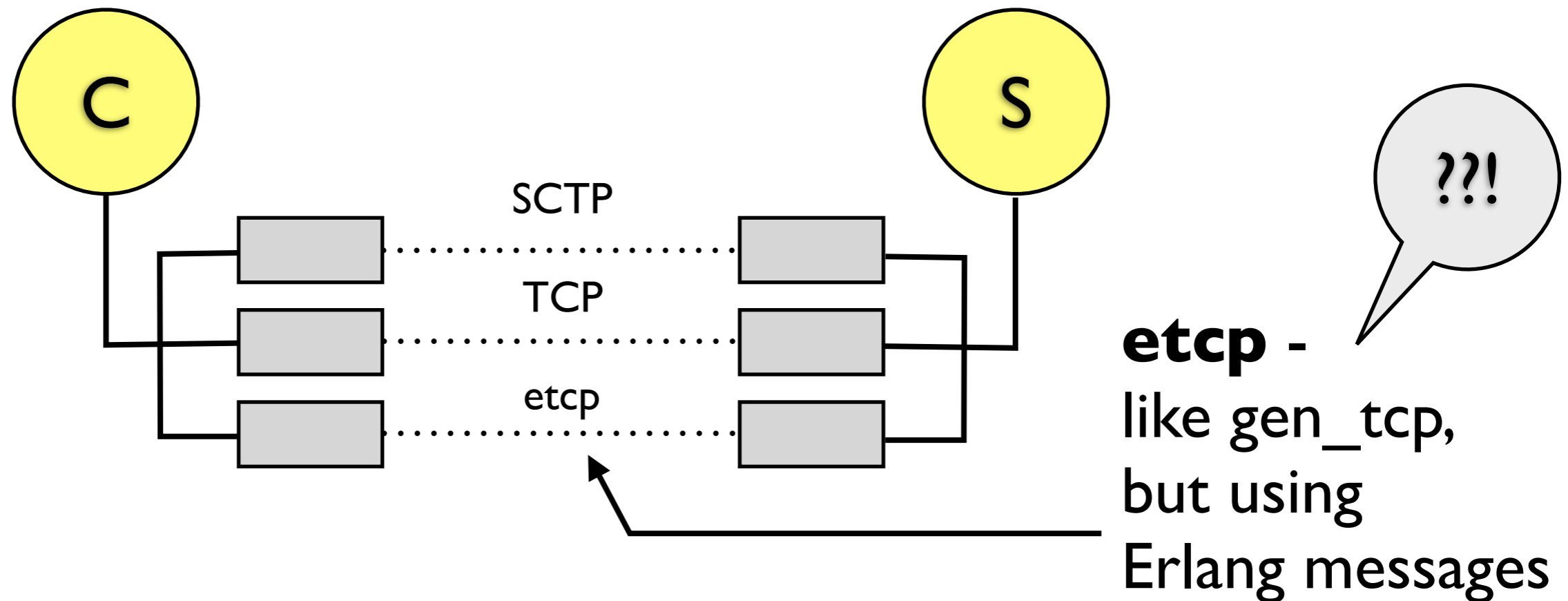
- Evaluated some 3rd party stacks written in C
  - Expensive
  - “Full-featured”, but still needing customization
  - Lots of C-Erlang adaptation work expected
- One Erlang-based 3rd-party stack
  - Nice, but didn't have the add-ons we needed
  - More expensive than to build an in-house stack
- In-house alternative: I wrote first version (6-7 months)
  - Anders Svensson, later OTP, took over
  - Rewrote the whole thing...

# Requirements

- **Fast**
  - 3-4 Diameter calls per session setup
    - On top of lots of SIP-related activity
  - Total session setup latency budget: **20 ms**
- **Flexible**
  - 3GPP and TISPAN interfaces a moving target
  - Embrace and extend attitude
- **Easy to use**
  - Fast-paced & complex development project

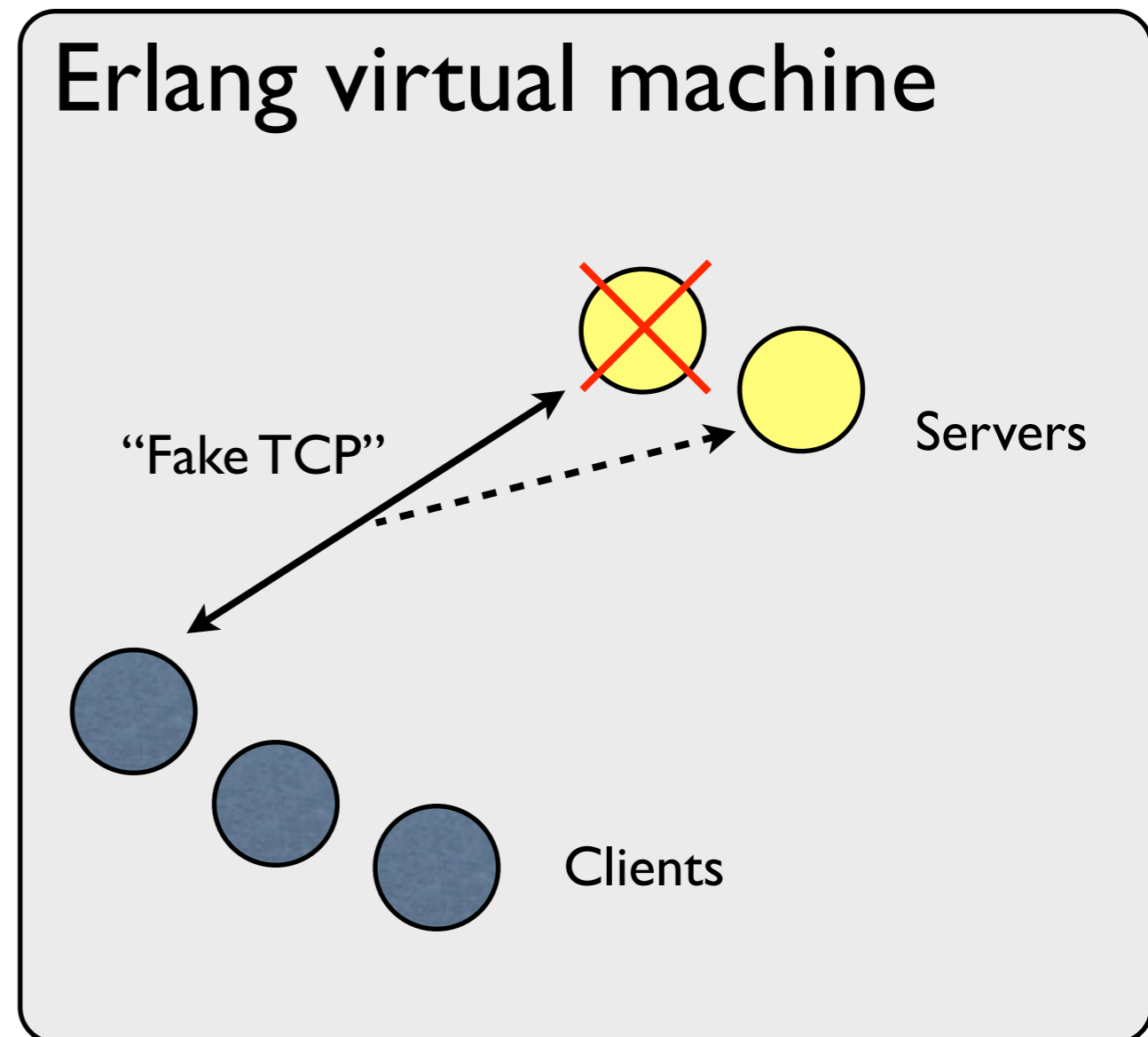
# Only the Client Needed (...?)

- Yes, ...but how to test a client?
  - No e2/Rx/Ro Diameter server simulators existed
- Solution: write a server too!



# Erlang - Testing Nirvana

- Superb testing tools
- Dead-simple to write stubs and simulators
- Secret sauce for interoperability testing
- Revealed many bugs in the specs...



# Summary

- Cheaper to build from scratch in Erlang than to buy and integrate off-the-shelf C code
  - Great way to learn the protocol too
- Already in use in several commercial products
  - Both Erlang and C++
  - Both client and server



# RFC written for C programmers

Example: RFC 3588 - DIAMETER Base Protocol

| state  | event         | action        | next state |
|--------|---------------|---------------|------------|
| ...    |               |               |            |
| I-Open | Send-Message  | I-Snd-Message | I-Open     |
|        | I-Rcv-Message | Process       | I-Open     |
|        | I-Rcv-DWR     | Process-DWR,  | I-Open     |
|        |               | I-Snd-DWA     |            |
|        | I-Rcv-DWA     | Process-DWA   | I-Open     |
|        | R-Conn-CER    | R-Reject      | I-Open     |
|        | Stop          | I-Snd-DPR     | Closing    |
| ...    |               |               |            |

Transport FSM

Handshake FSM

- Three state machines described as one
- Implies a single-threaded event loop
- Introduces accidental complexity

# DIAMETER, Erlang-Style

## Handshake FSM

- Capabilities exchange
- Leader election
- Only active during handshake

## Dynamic request handler

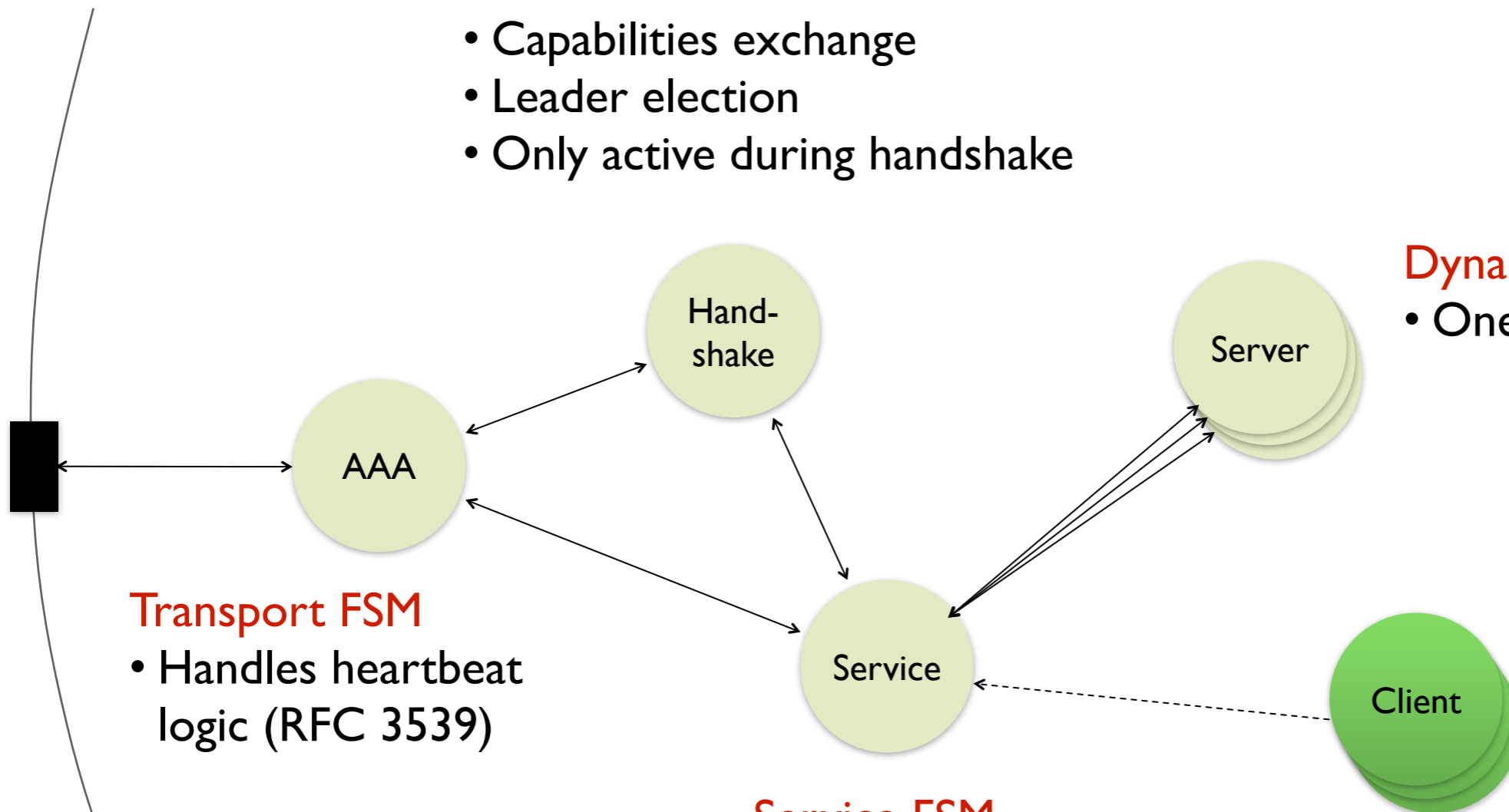
- One per request

## Transport FSM

- Handles heartbeat logic (RFC 3539)

## Service FSM

- Request routing
- Failover
- Retransmission



# Defining a Diameter “application”

Copy-paste from the spec  
into a .dia text file

```
@id 0  
@prefix diameter_base  
@vendor 0 IETF
```

ml9-style  
headers

```
@avp_types
```

```
Acct-Interim-Interval      85  Unsigned32  M  
Accounting-Realtime-Required 483  Enumerated  M  
Acct-Multi-Session-Id     50   UTF8String  M  
...  
Proxy-Info                284  Grouped    M
```

AVPs =  
Attribute-Value Pairs

```
...  
@messages  
...
```

Compound type

# Defining a Diameter application (2)

@messages

CER ::= < Diameter Header: 257, REQ >

{ Origin-Host }

{ Origin-Realm }

1\* { Host-IP-Address }

{ Vendor-Id }

{ Product-Name }

[ Origin-State-Id ]

...

\* [ Vendor-Specific-Application-Id ]

[ Firmware-Revision ]

\* [ AVP ]

{Mandatory}

[Optional]

CEA ::= < Diameter Header: 257 >

{ Result-Code }

{ Origin-Host }

{ Origin-Realm }

...

# Defining a Diameter application (3)

@enum Disconnect-Cause

|                            |   |
|----------------------------|---|
| REBOOTING                  | 0 |
| BUSY                       | 1 |
| DO_NOT_WANT_TO_TALK_TO_YOU | 2 |

@grouped

```
Proxy-Info ::= < AVP Header: 284 >  
    { Proxy-Host }  
    { Proxy-State }  
    * [ AVP ]
```



Compound type

# Generated Erlang module

```
-module(diameter_gen_base_rfc3588).  
-compile([parse_transform, diameter_exprecs]).  
...  
-export_records([diameter_base_CER, diameter_base_CEA,  
    ...,  
    'diameter_base_E2E-Sequence']).  
  
-record(diameter_base_CER,  
    {'Origin-Host', 'Origin-Realm', 'Host-IP-Address' = [],  
    'Vendor-Id', 'Product-Name', 'Origin-State-Id' = [],  
    'Supported-Vendor-Id' = [], 'Auth-Application-Id' = [],  
    'Inband-Security-Id' = [], 'Acct-Application-Id' = [],  
    'Vendor-Specific-Application-Id' = [],  
    'Firmware-Revision' = [], 'AVP' = []}).  
  
...
```

Like 'exprecs' in  
[http://github.com/esl/  
parse\\_trans](http://github.com/esl/parse_trans)

The Erlang/OTP DIAMETER Stack  
or  
What's all about?

6/14/11


Erlang Factory London 2011

## About me...

- Holger Winkelmann
- Founder & MD of Travelping GmbH
- Working for ISP & Telco for 16 Years
- AAA and Control Plane Expertise



# What's DIAMETER ???

 **Erlang Programming**

Erlang/OTP R14B03 has been released

[Options](#)

★ 8 messages - [Expand all](#) - [Report discussion as spam](#)

**Björn-Egil Dahlberg** Erlang/OTP R14B03 has been released. This release is mainly a stabili: May 25, 4:06 pm

▶ **Slav Pankratov** [View profile](#)

[More options](#) May 25, 4:10 pm

Hello!

I am Erlang newbie, what's "Diameter"?

thanks,  
Slav

---

erlang-questions mailing list  
erlang-questi...@erlang.org  
<http://erlang.org/mailman/listinfo/erlang-questions>

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1st email after Release

# Another Protocol in Erlang/OTP

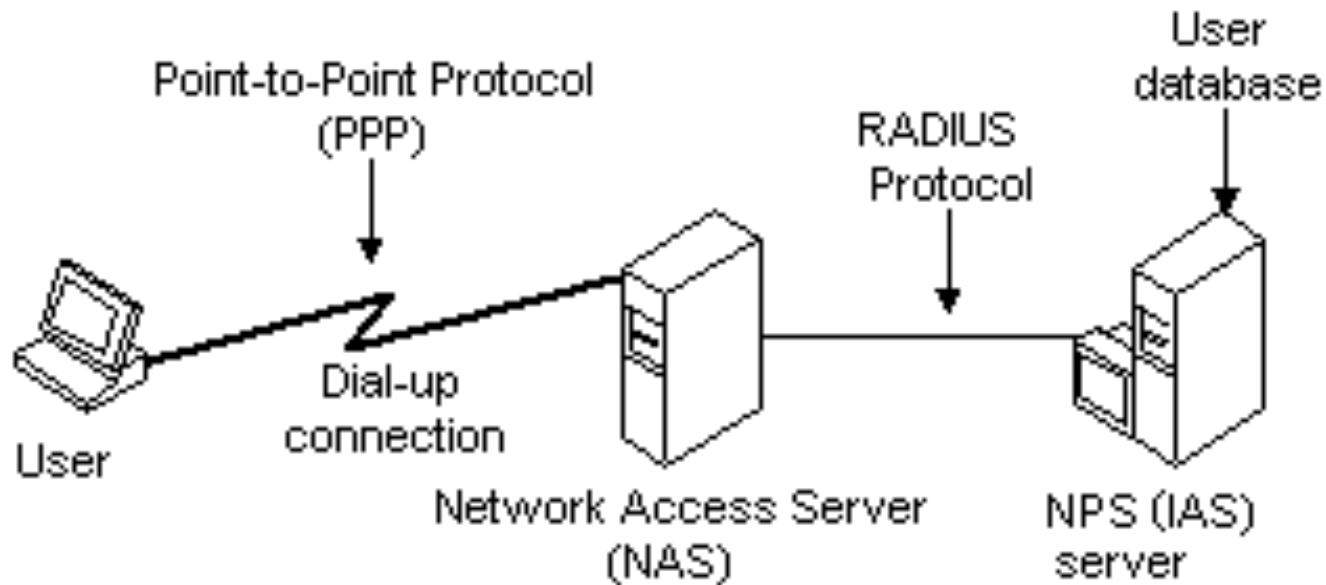
- Erlang/OTP – a protocol factory
- Already many Telco centric Implementations
- ASN.1, SNMP, MEGACO, H.248
- DIAMETER stack is used in many Telco Products
- The DeFacto Control Plane Protocol in Mobile Operators Networks
- Defined in RFC3588... and many 3gpp TS

# DIAMETER – RADIUS History

- **Diameter** is an authentication, authorization and accounting (**AAA**) protocol for computer networks, and a successor to **RADIUS**
- **Remote Authentication Dial In User Service (RADIUS)** is a networking protocol that provides centralized Authentication, Authorization, and Accounting (AAA) management for computers to connect and use a network service.

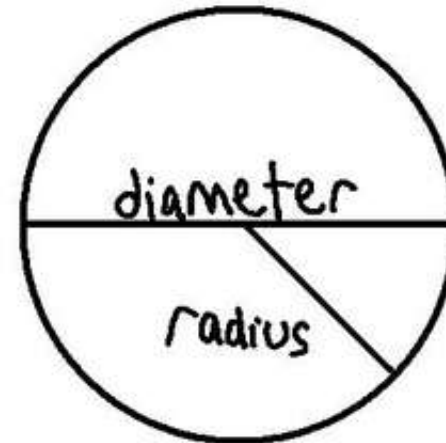
# How RADIUS Works

- **RADIUS** – UDP based protocol defined in RFC2865 – RFC2866 plus man other.
- **ISP Dial-In Example**



# DIAMETER vs. RADIUS

- The name is a pun on the **RADIUS** protocol, which is the predecessor (a diameter is twice the radius). **DIAMETER** is not directly backwards compatible, but provides an upgrade path for **RADIUS**.



Twice the  
Radius!

# DIAMETER Differences

- Reliable transport protocols (TCP or SCTP, not UDP)
- Network or transport layer security (IPsec or TLS)
- Transition support for RADIUS, although Diameter is not fully compatible with RADIUS
- Larger address space for attribute-value pairs (AVPs) and identifiers (32 bits instead of 8 bits)
- Client–server protocol, with exception of supporting some server-initiated messages as well
- Both stateful and stateless models can be used
- Dynamic discovery of peers (using DNS SRV and NAPTR)
- Capability negotiation, Error notification
- Aligned on 32-bit boundaries

# Diameter Applications

- Separation between Base Protocol and Application
- DIAMETER Application is NOT a Software Application
- Diameter Applications are define as:
  - Application Identifier
  - Command Codes
  - Mandatory Attribute Value Peers (AVPs)
- more like a specification, contract or dictionary rather a Application.
- DIAMETER allows to define multiple Applications and can be widely for AAA Purposes

# Sample Applications

- Diameter Mobile IPv4 Application (MobileIP, RFC 4004)
- Diameter Network Access Server Application (NASREQ, RFC 4005)
- Diameter Extensible Authentication Protocol Application (RFC 4072)
- Diameter Credit-Control Application (DCCA, RFC 4006)
- Diameter Session Initiation Protocol Application (RFC 4740)
- Various applications in the 3GPP IP Multimedia Subsystem (IMS)



# Usage of DIAMETER

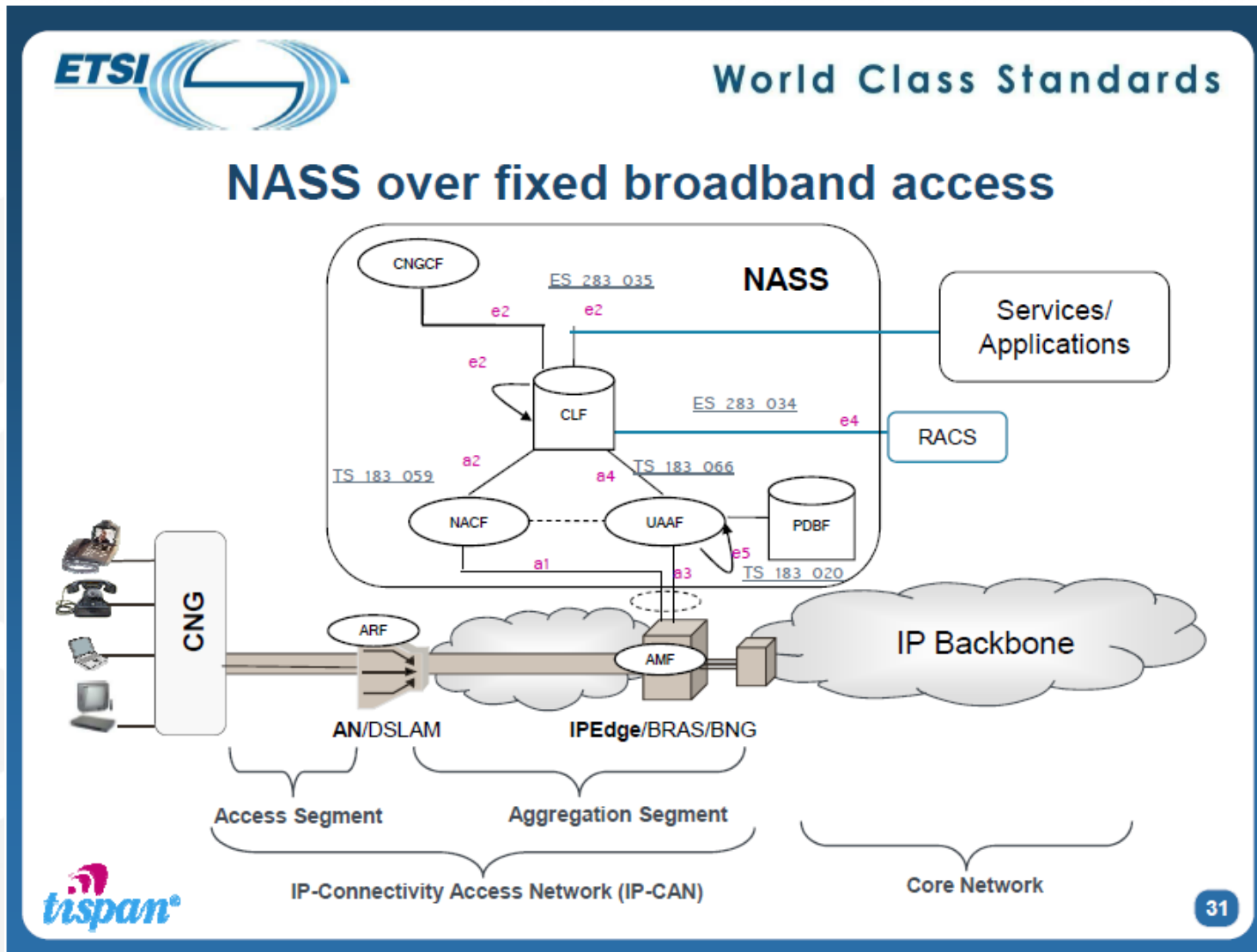
- Not very Successful as **RADIUS** successor. RADIUS is still widely used in ISP and Enterprise Networks.
- Widely used as Control Protocol in 3GPP defined IMS Networks.



- Gets adopted by ETSI TISPAN for all IP Migration of fixed line Telco Networks (NGN)



# NGN - TISPAN Interfaces



# DIAMETER Market

- Application Developer can connect Applications to IMS based Networks. (i.e. Location based Services)
- Opensource Erlang DIAMETER Stack can be used for Testing.
- The Web get's a DIAMETER Application:

```
[Docs] [txt|pdf|html] [Tracker] [Email] [Diff1] [Diff2] [Nits]
```

```
Versions: 00 01
```

```
Network Working Group
```

```
Internet-Draft
```

```
Expires: January 14, 2010
```

```
N. Neumann
```

```
X. Fu
```

```
University of Goettingen
```

```
July 13, 2009
```

```
Diameter Application for Authentication and Authorization in Web
```

```
Applications
```

```
draft-neumann-dime-webauth-01
```

# Erlang/OTP DIAMETER

Handover to Ulf Wiger