TATA COMMUNICATIONS

GSMA IPX Trial

Tata Communications

TELUS

Telekom Austria

IPX PCI Trial Management Team Meeting
TMT#21, 16-17 September 2008

TATA

Overview

Tata, in conjunction with our partners, TELUS and Telekom Austria, have successfully completed voice calls between Mobile Network Operators (MNO) according to the GSM Association's (GSMA) specifications regarding the IP eXchange (IPX) framework.

The highlight of this effort was demonstrating successful interoperability between the following two distinct ISUP standards.

- **The North American ANSI standard (ANSI88) utilized by TELUS.**
- **The European ITU-T standard (ITU-T92+) utilized by Telekom Austria.**

The IPX is the GSMA's proposal for the next generation interconnect solution. It provides a commercial and technical solution to manage IP traffic for voice and content, and follows the GSMA's four key IP Interworking (IPI) principles of openness, quality, cascading payments and efficient connectivity.

Ingredients For Success

Great Partners

- *Telekom Austria*
- *TELUS*
- *Mobile Network Operators*

Strong Support Organizations

- *Standards Bodies*
- *Internal Management Teams*
- *Vendors*

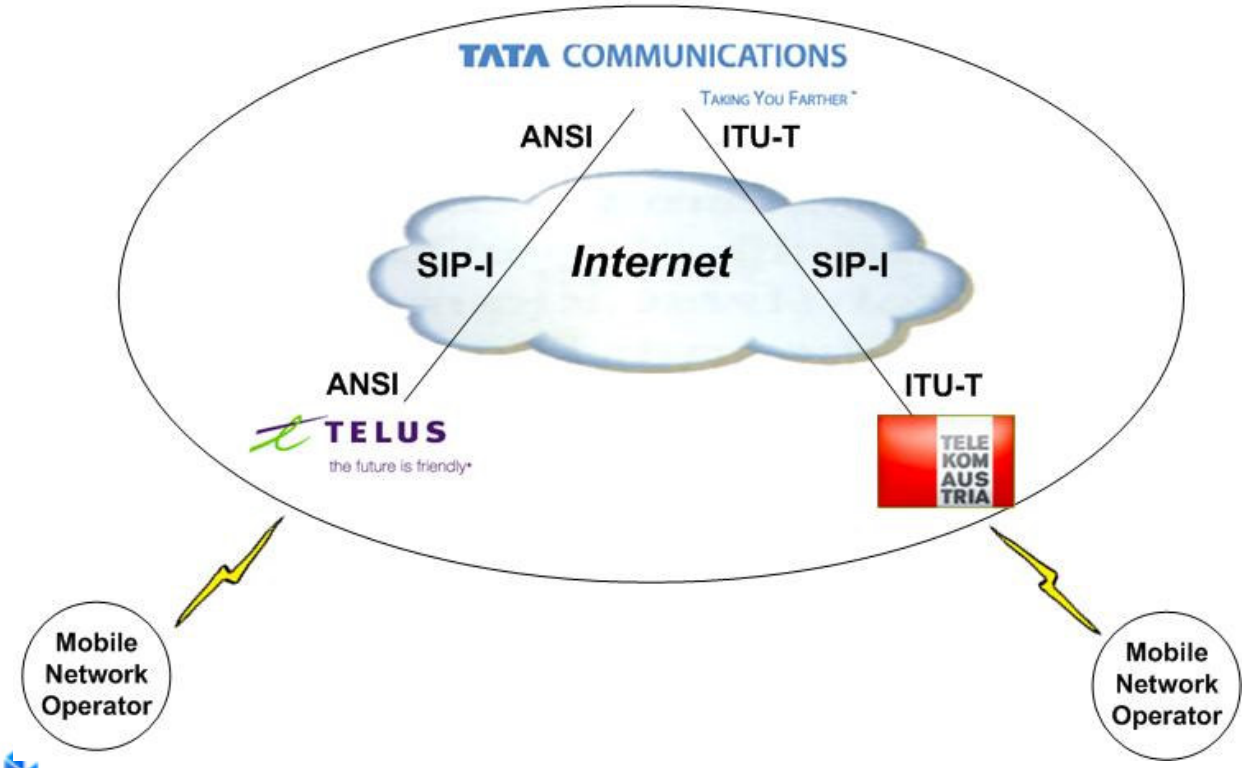
Flexible Network Elements

- *Media Gateways*
- *Session Border Controllers*
- *SIP Proxies, Back-to-Back User Agents*

High Level Architecture

Tata Communications is configured to preserve call control information by encapsulating ISUP, utilizing SIP-I (Q.1912.5) as follows:

- **ANSI** between Tata Communications and Telus
- **ITU-T** between Tata Communications and Telekom Austria



Key Findings / Lessons Learned

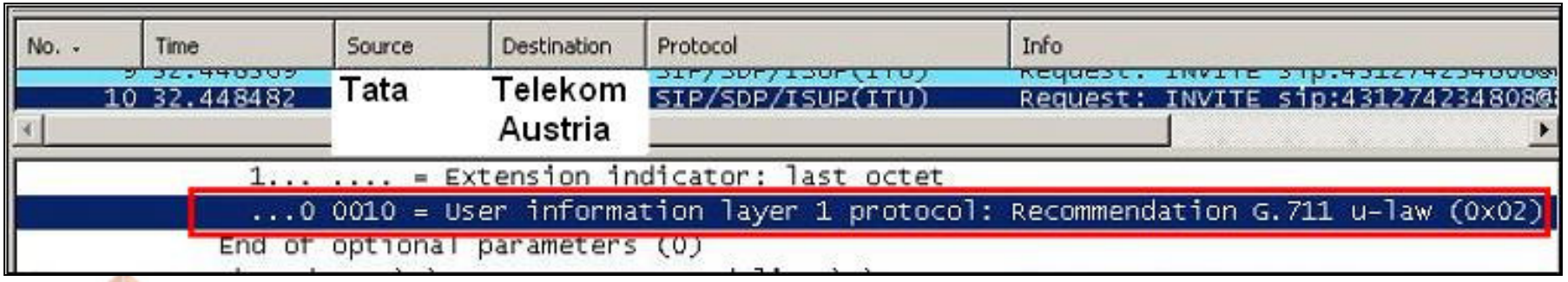
Interoperability Between ANSI and ITU-T 'Base' Variants

Due to differences in the parameters defined by the ANSI and ITU-T 'Base' variants, many issues regarding interoperability required resolution. The trace below shows that ISUP was not encapsulated (via SIP-I, Q.1912.5) between Tata and Telekom Austria due to (ANSI88) parameters received from TELUS that were not conformant with the ITU-T92+ variant. Resolving this issue required modifying or eliminating parameters on either the ANSI88 or ITU-T92+ variant.

Key Findings / Lessons Learned

Interoperability Between Partners Network Implementation (1)

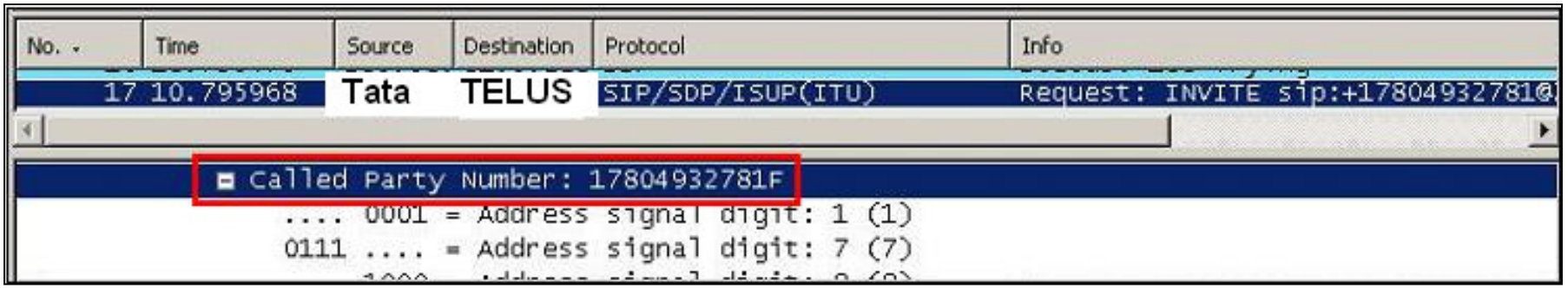
Successfully completing a call across the IPX network required the resolution of issues regarding our partners' network implementation. These issues corresponded to the network elements used by our partners, as well as unique parameters/settings required/utilized for their respective VoIP/TDM networks. The trace below shows that G.711 u-law was included in the encapsulated ISUP sent from Tata to Telekom Austria. Since Telekom Austria uses G.711 a-law, the call to failed on the TDM part of Telekom Austria's network. Resolving this issue required eliminating the User Service Information sent to Telekom Austria.



Key Findings / Lessons Learned

Interoperability Between Partners Network Implementation (2)

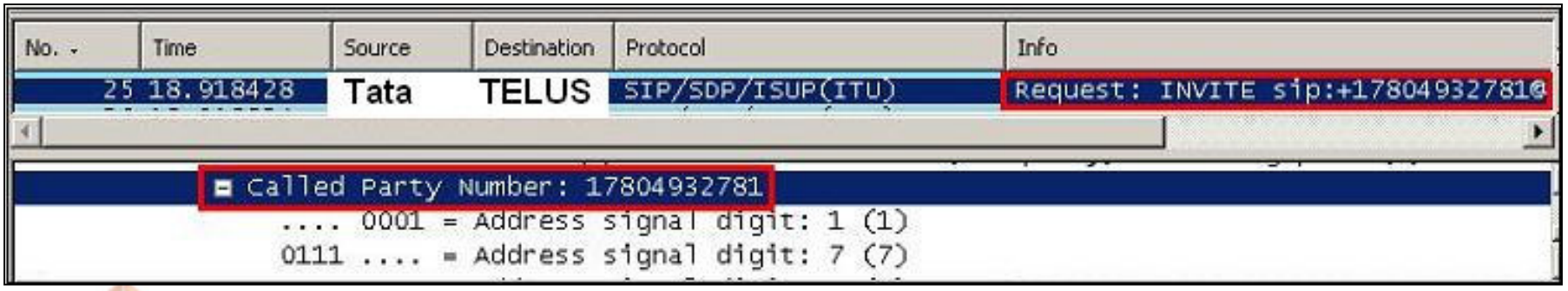
Another example regarding interoperability between our partners' network implementation involved the use of a 'stop' bit to terminate the received digit string for the Called Party Number (CPN). The trace below shows that a 'stop' or 'F' bit was sent in the ISUP CPN to TELUS, which eventually caused the call to fail on the TDM part of the TELUS network. Resolving this issue required eliminating the 'F' bit in the CPN sent to TELUS.



Key Findings / Lessons Learned

Interoperability with SIP, ISUP and E.164

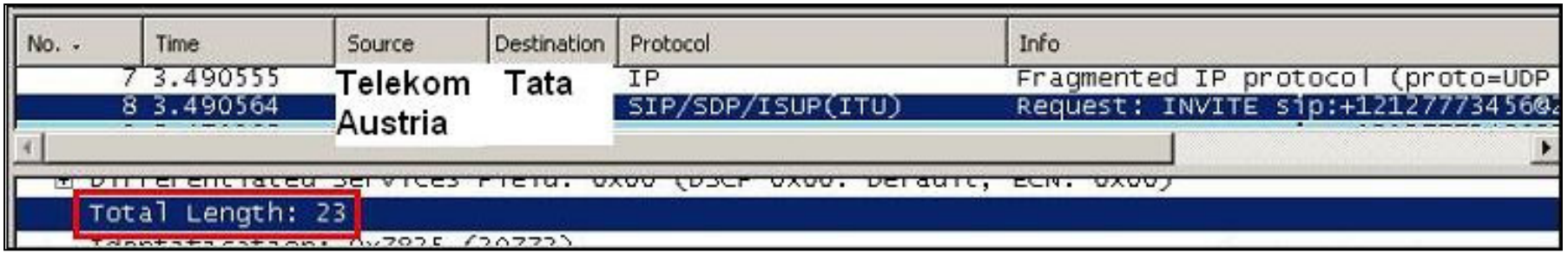
Due to requirements for call routing in our partners' VoIP networks, SIP INVITEs were formatted according to the E.164 standard. There was an issue where the leading '+' symbol, utilized in the E.164 standard, was required in the SIP 'URI' and 'To' field to facilitate VoIP call connectivity. However, the '+' symbol caused issues with ISUP encapsulation, therefore a solution to include the '+' symbol for SIP and exclude it for ISUP was required. The trace below shows an example of the format required to complete calls to TELUS VoIP and TDM networks. Note that the issue regarding the 'stop' bit shown in the previous slide has been addressed.



Key Findings / Lessons Learned

IP Fragmentation

Due to ISUP encapsulation, SIP messages are larger and IP fragmentation may occur. There were scenarios where fragmentation allowed for IP packets with small payloads, which were consistently dropped over the IP network. This caused issues with B2BUAs waiting for additional fragmented packets and thus not having the ability to reconstruct SIP INVITE messages if these packets were dropped. The trace below, obtained from Telekom Austria's network, shows a packet originating from Telekom Austria. The packet, part of a SIP INVITE message was fragmented with one packet having a total length of 23 bytes. This packet was dropped in the IP network, never arriving at the terminating side. Resolving this issue required eliminating codecs that were sent in the SDP from Telekom Austria. Doing this allowed for 'shorter' SIP messages that were not fragmented. For this trial, SIP was transported via UDP. It may have been possible that using TCP might have addressed this issue, however this was not verified.



Questions ?

Playback of first successful call between MNOs over TATA-TELUS-Telekom Austria IPX network.