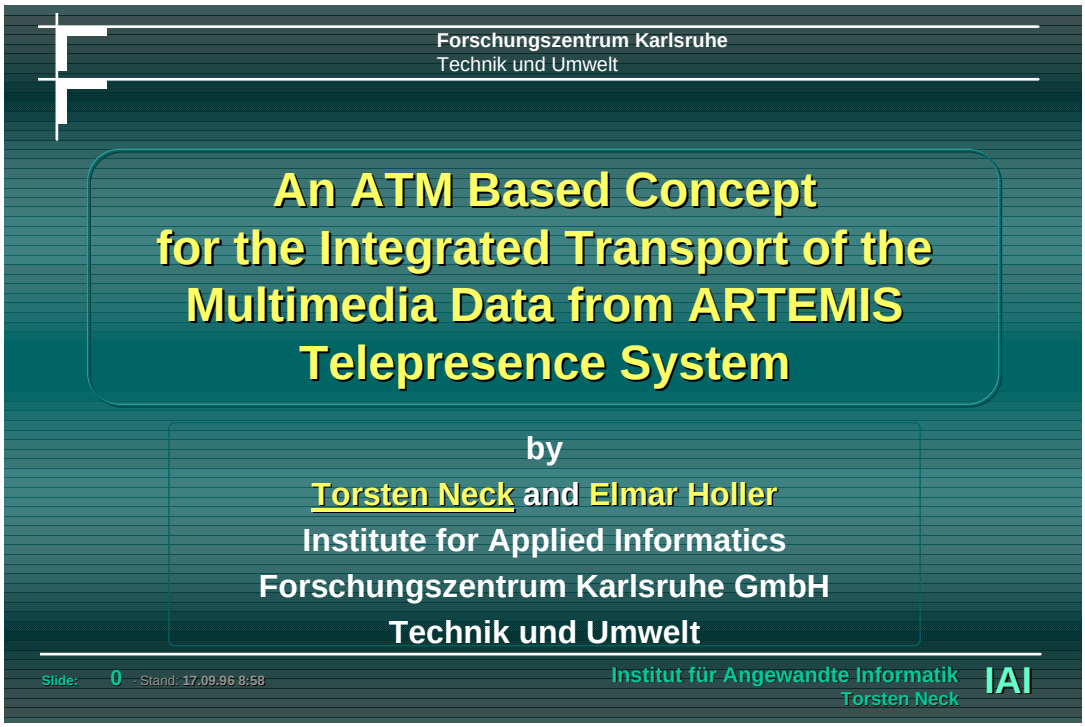
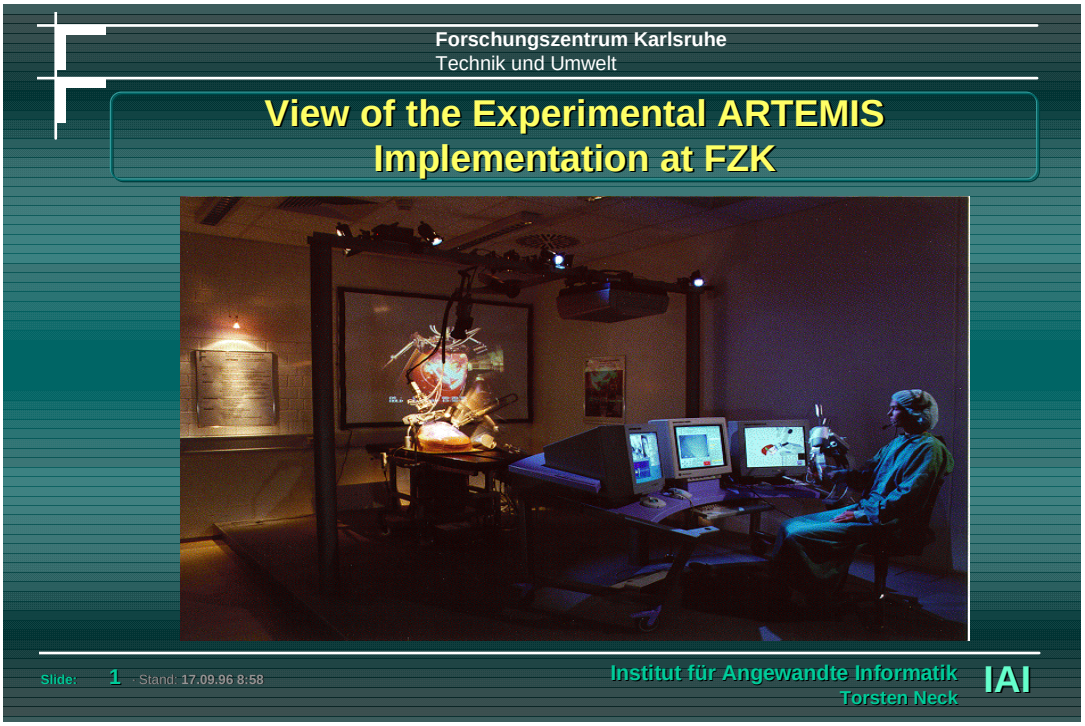
Society for Minimally Invasive Therapy
Eighth International Meeting, 18–20 September 1996
Villa Erba, Cernobbio, Italy

Torsten Neck and Elmar Holler
Forschungszentrum Karlsruhe GmbH Technik und Umwelt
Institut für Angewandte Informatik

AN ATM BASED CONCEPT FOR THE INTEGRATED TRANSPORT OF THE MULTIMEDIA DATA FROM ARTEMIS TELEPRESENCE SYSTEM

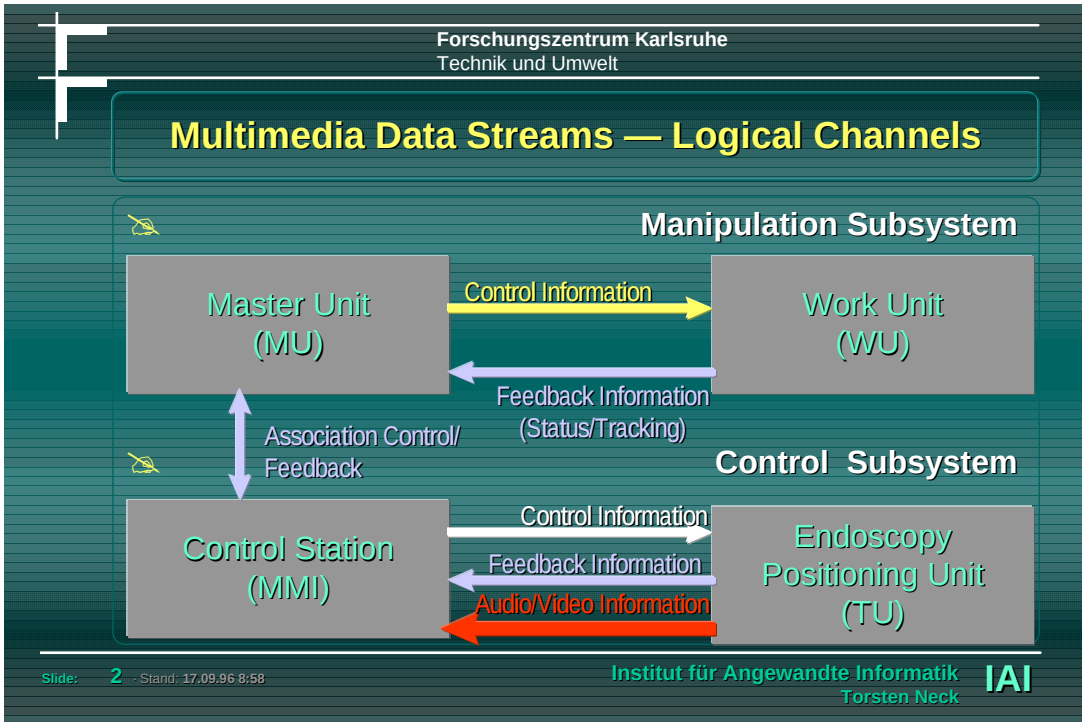


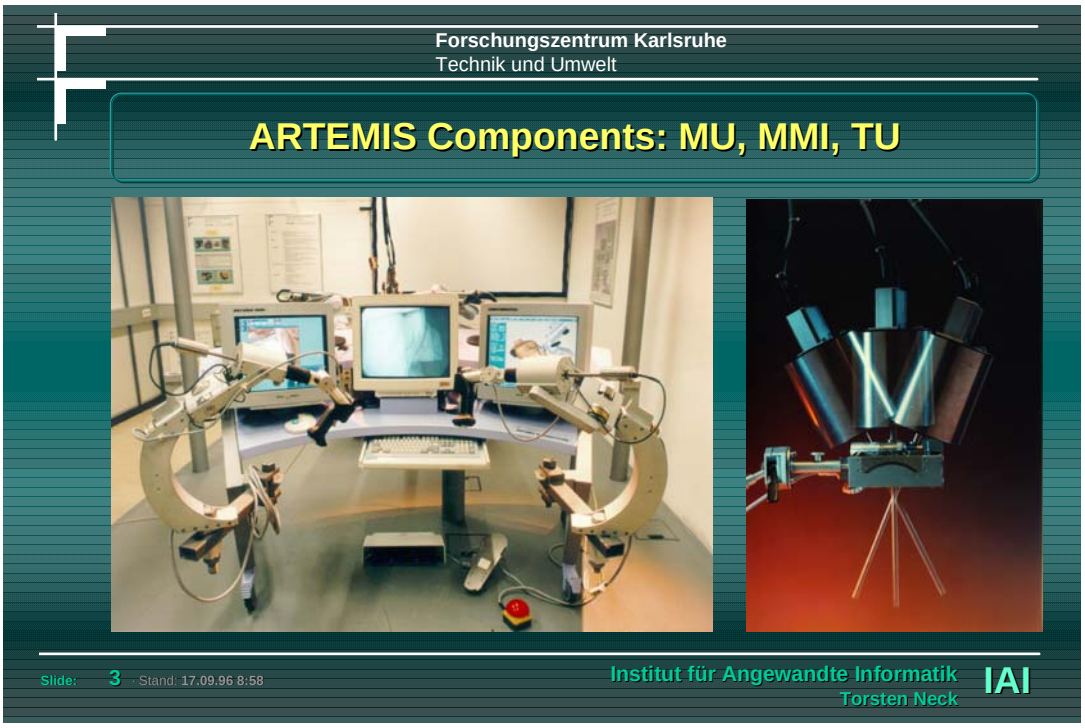


Mr. Chairman, thank you very much for your introduction.

Dear Sirs, ladies and gentlemen,

[Slides 0 and 1] I would like to present you an ATM based concept, which allows to control our telepresence system ARTEMIS in the usual manner – using MONSUN – but which is also capable of
integrating the necessary audio and video information originated by surrounding cameras and especially the endoscope. May we have the next slides, please.





[Slides 2 and 3] As you already know the ARTEMIS system consists of at least **4 units:**

- the **master unit (MU)** which controlls [slide 3 left picture]
- the **telemanipulator or work unit (WU)**. [slide 3 left picture in the background]

Together, they build the **telemanipulation subsystem.** In addition there exists – important for the feedback – what I call the **control subsystem,** consisting of the

- **control station**, called **Man Machine Interface (MMI)** [slide 3 left pictre foreground] and
- the **endoscopy positioning unit** with the endoscope camera which – in terms of the MONSUN control concept – is a **Tracking Unit (TU**) [slide 3 right picture]

Between these units the typical **MONSUN information channels** are established **independently [slide 2]**:

- first of all: the most important **control channel** which makes up the **telemanipulation itself**
- and there is some **feedback information** (actual position for tracking purposes, or force reflection) from the WU to the Master.

In the **control subsystem** you can see

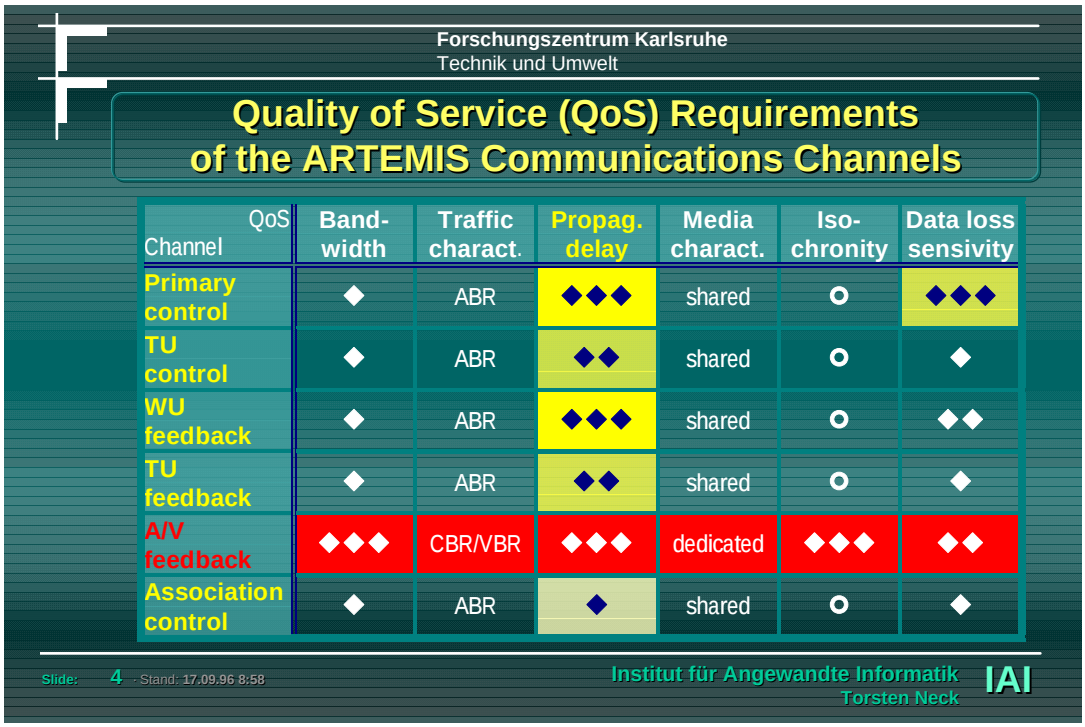
- an **additional control information channel** for the positioning actions of the endoscopy positioning unit
- the **correspondent feedback channel** carrying the actual position and
- most important in this subsystem: **the audio video information from the endoscope itself**.
- You will also find the association control and feedback channel which makes the link between the two subsystems.

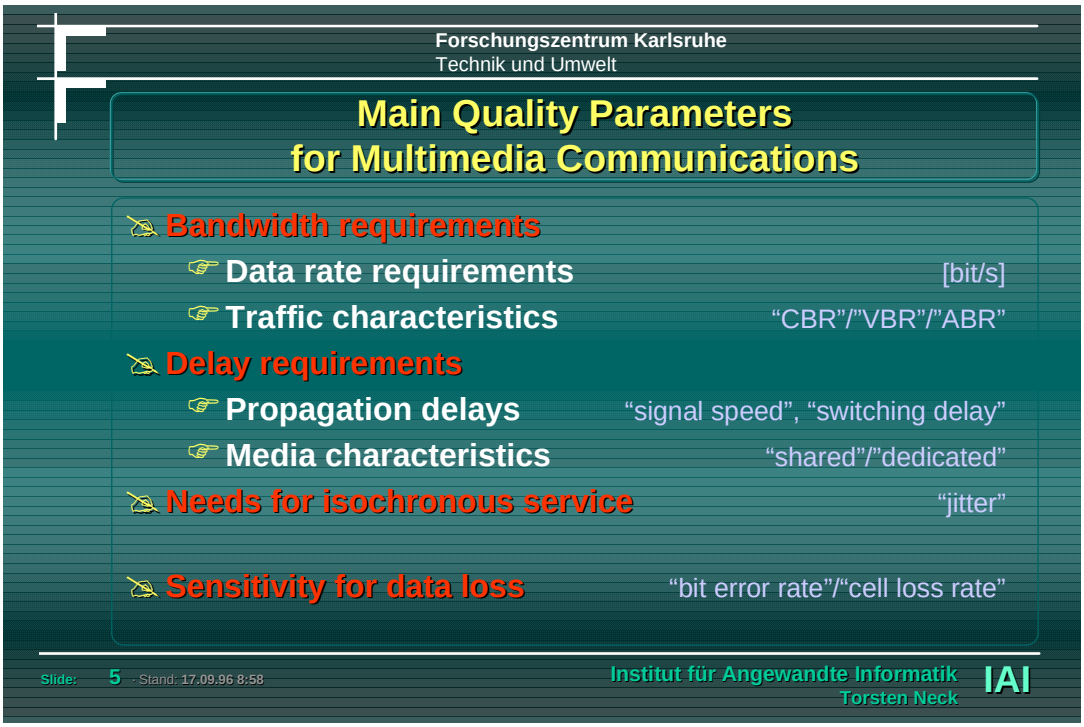
With respect to the different **types** of information

- **discrete information** in the control context and
- **continuous audio and video** information

we are confronted with a typical **MULTIMEDIA SYSTEM**.

Please, let me show you some more detailed characteristics of those multimedia data channels with the next slides — may we have them, please.





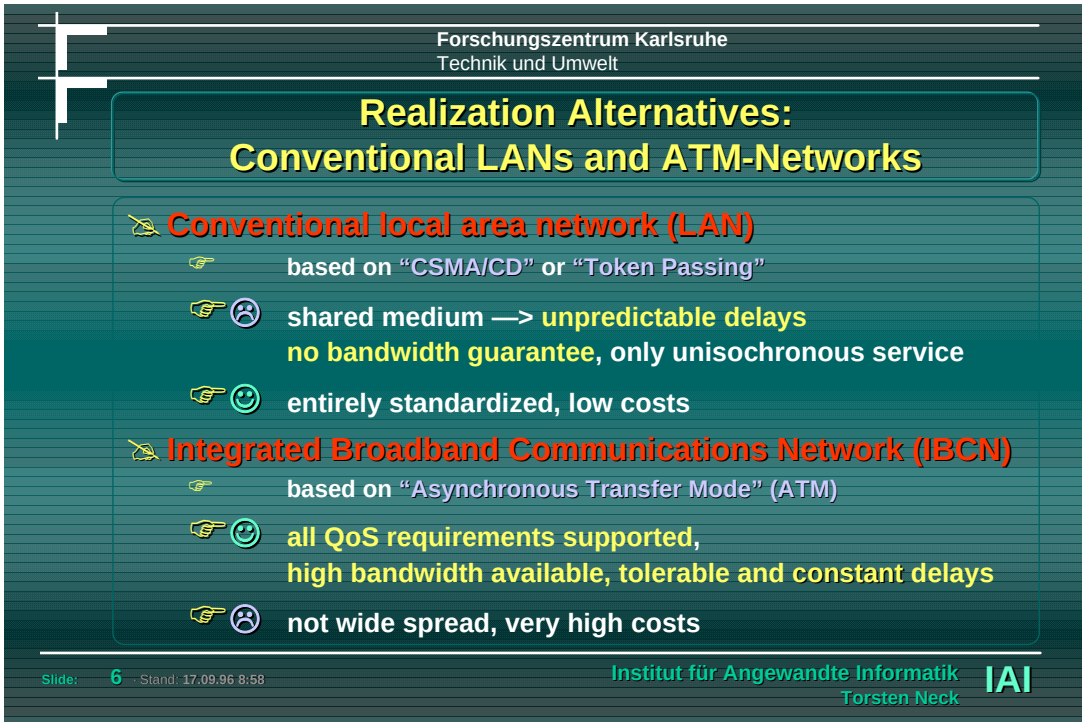
[Slides 4 and 5] This matrix lists up all the independent **information channels** which I have introduced. They are arranged in the **lines** of the matrix. The columns show some **Quality of Service parameters** which are explained by the right slide.

I only want to point out the most important details:

- As you can see in the **bandwidth column**, telemanipulation is **not** a problem of high bandwidth,
- the only bandwidth consuming information in the whole system is the A/V channel.

- The **A/V channel** is a **completely different** type of data flow compared to control and feedback channels.
  This is due to the fact, that A/V **represents** the **continuous medium** wheras **all other** channels are of the **discrete** type.

What else is to be underlined? It is: **The propagation delay is the determining quality parameter** for the whole telepresence system, **for all types of channels**!



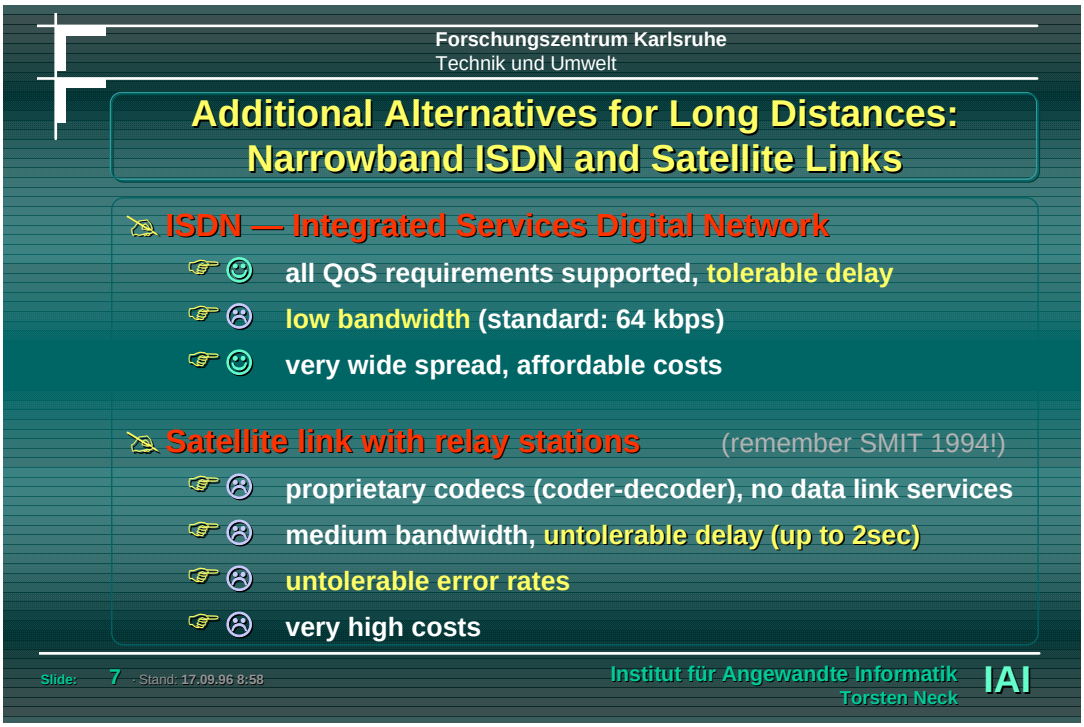
[Slide 6] So let us have a look at the different network candidates for the realization of the ARTEMIS multimedia system:

- First, we have the **conventional local area networks** like **Ethernet** or **FDDI**: their **benefits** are, that they are **entirely standardized** and **available all over the world** at **low costs, but**, as I have put it down on the slide, their **disadvantages** are the **shared media** which **lead to unpredictable delays**, and the **absence of bandwidth guarantees**, which only allow an **un-isochronous** communication service.

  Though, with adequate restrictions, they are **acceptable for the control** channels, they are **not suitable for the continous media** audio and video.

- For these media we should use ATM networks like the **IBCN** or **B-ISDN**: With them we can **provide** the **corresponding data services** in a very **flexible manner**, with them **high bandwidths** are available and there are **short delays** (in the range of microseconds) and these short delays are **deterministic and constant**!

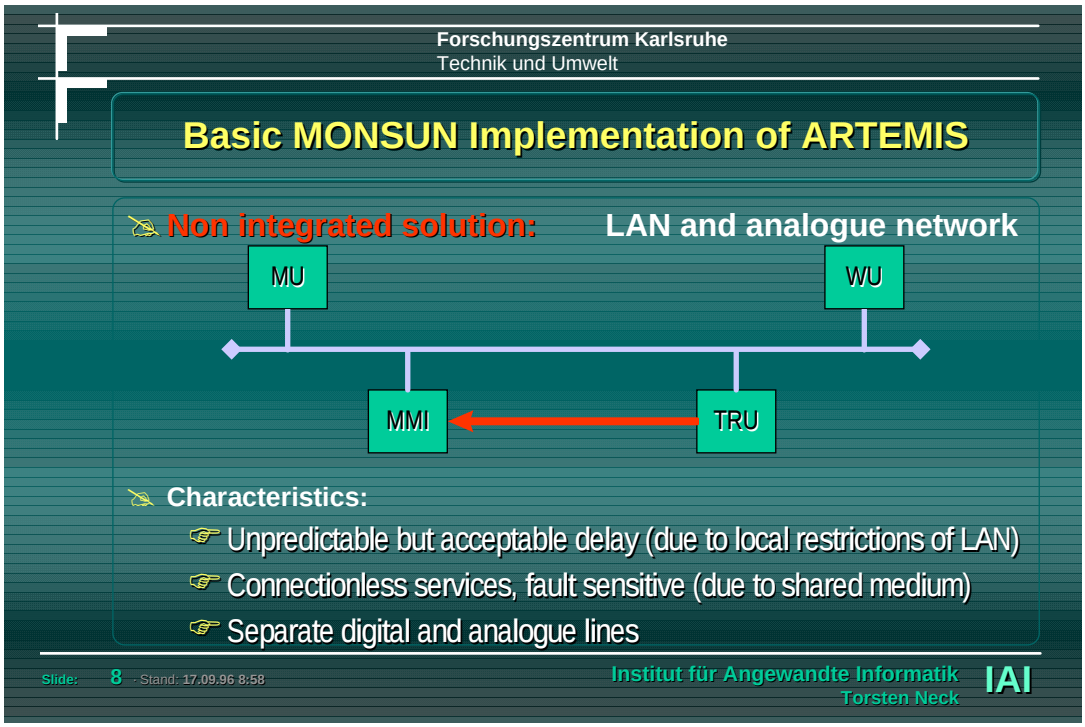
  The **disadvantage** of ATM is that it is a new technology which is not very wide spread up to now, and only available at expensive costs!



[Slide 7] Let's take a glance at the long distance alternatives, too:

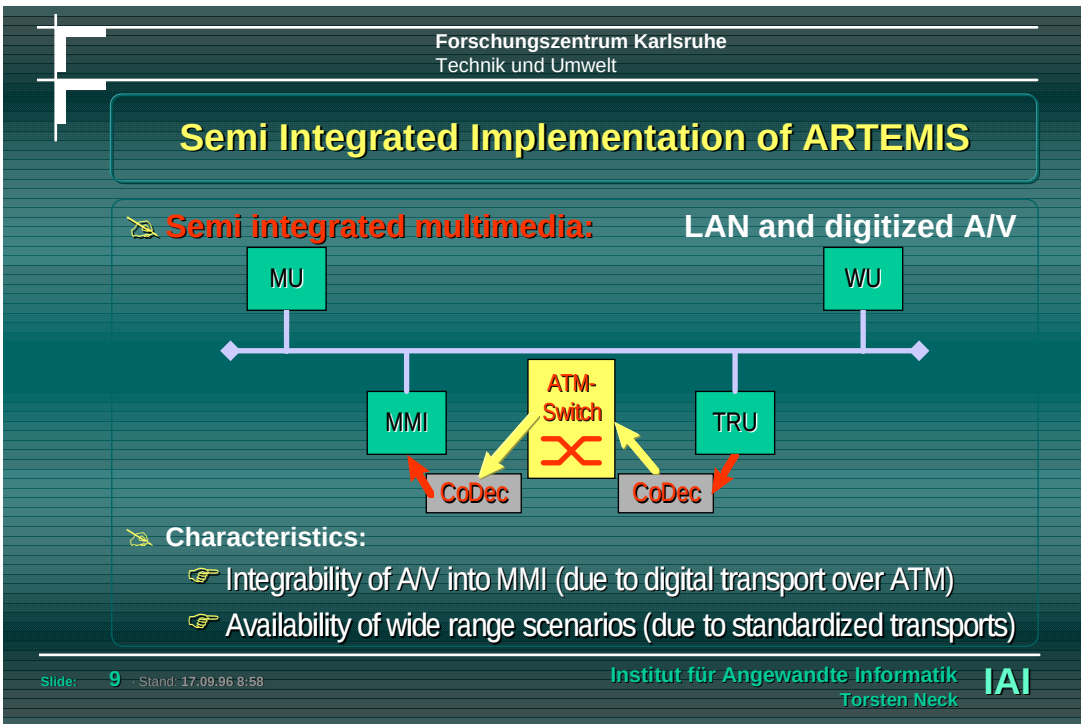
If we look for a wide spread **long distance network** which may be used for a multimedia telepresence system (for **teleconsultation** or **virtual reality teletraining**) at the moment the **only acceptable** candidate (besides ATM) might be the **narrowband ISDN**.

- The most important disadvantage of ISDN however is the lack of bandwidth, so that you are urged to cumulate up to 4 or 5 network endpoints.
- As you can read from the **sadly looking faces** in front of the **satellite characteristics this definitely** is **no adequate** solution! (Especially due to the fact that the main quality requirement for a telepresence system is the guarantee of short delays, and that is what is worst when you use a satellite: up to 3 secs roundtrip time!)



[Slides 8, 10, 12] In the ARTEMIS test bed we have started with a **non integrated** solution using **Ethernet** as the **digital control network** (shown by the light line) and **carrying the audio video information separateley** over analogue lines (the red arrow).

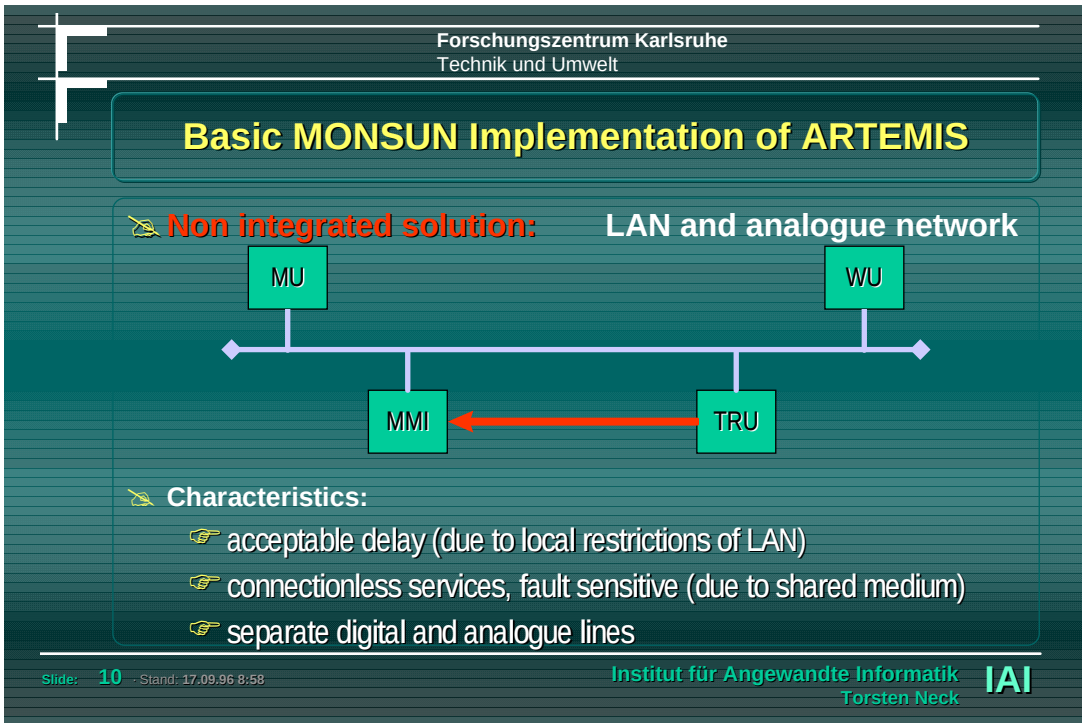
The delay problem is arbitrated by restricting the network access: on the ethernet segment only participants in the telepresence scenario are admitted.

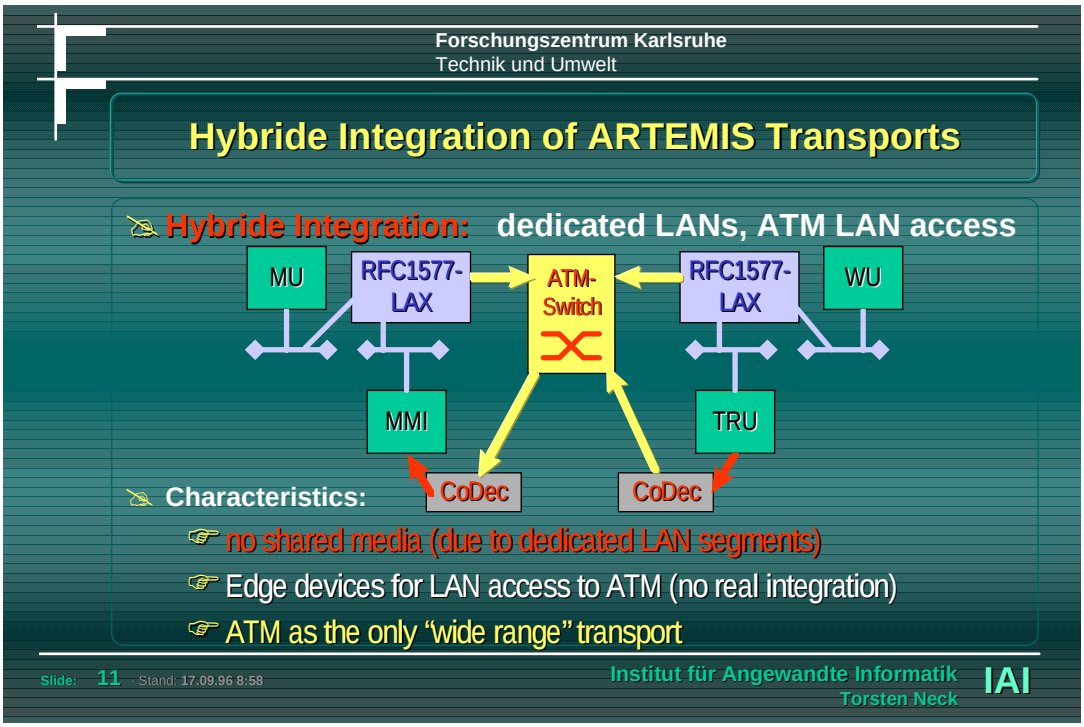


[Slide 9] Our first step towards integration was the **digitization of the audio video information** by the use of special ATM **coders and decoders** (you call them shortly **CODEC**s).

Due to the **standard coding and compression** technique it was possible to **partly integrate the video into the MMI** workstation.

With the digital transport of control **and** A/V information – still on two separate but **digital** networks – the scenario could be extended to **non local** use.

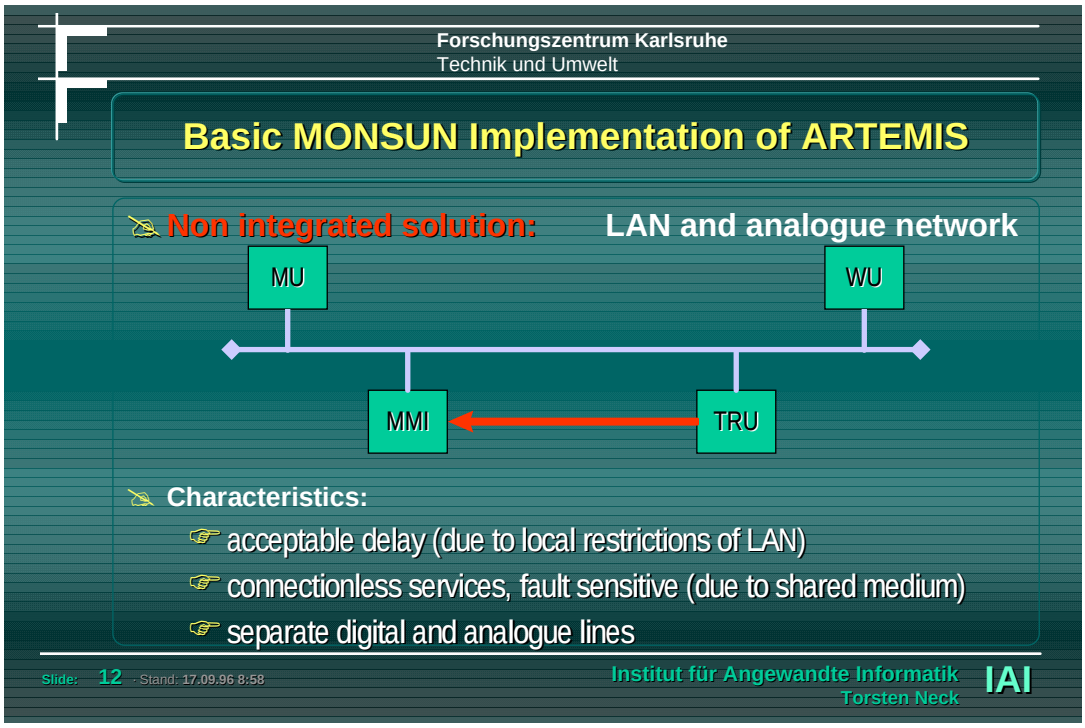


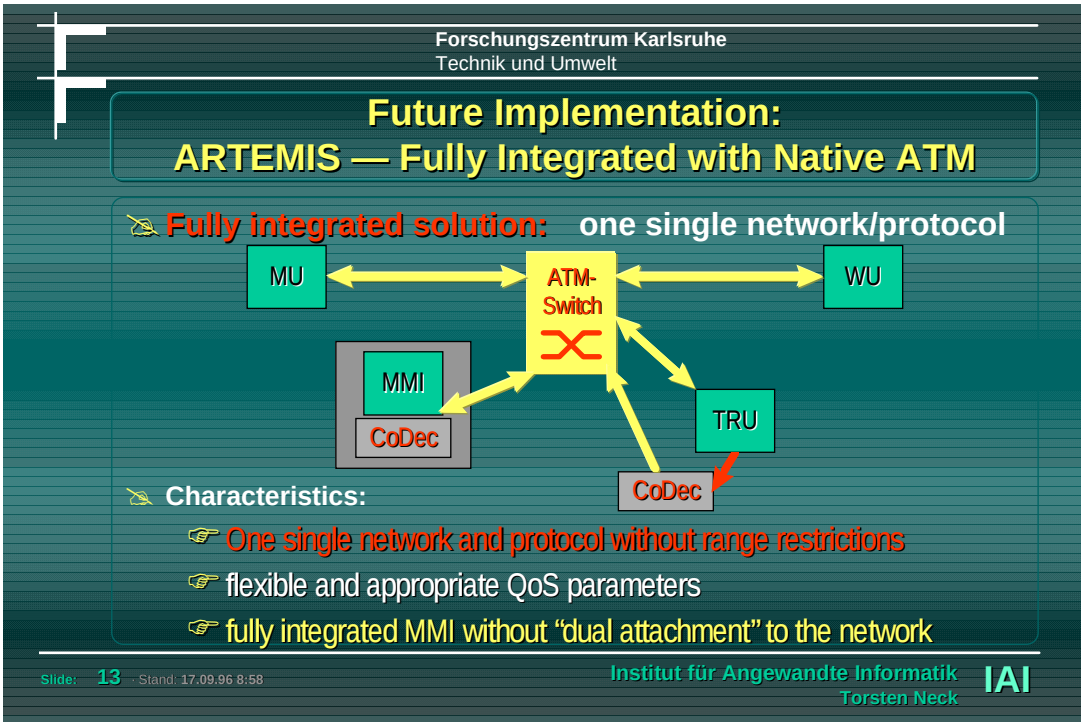


[Slide 11] The next step – and this is the state of our system at the moment – was to **banish** the **separate digital networks** to the **periphery** and to **bundle** all the data streams in the **one ATM interface transport**.

We introduced so called **EDGE DEVICES** or **LAN ACCESS SWITCHES** which permit **separate and independant Ethernet segments** to be **„BRIDGED OVER"** or **„TUNNELD THROUGH"** ATM.

Thus every unit has got it's own ethernet segment – eliminating 'access conflicts and reducing delay. All segments (and thus all units) are connected to the central ATM **high performance network** via the LAN ACCESS SWITCHES (LAX).

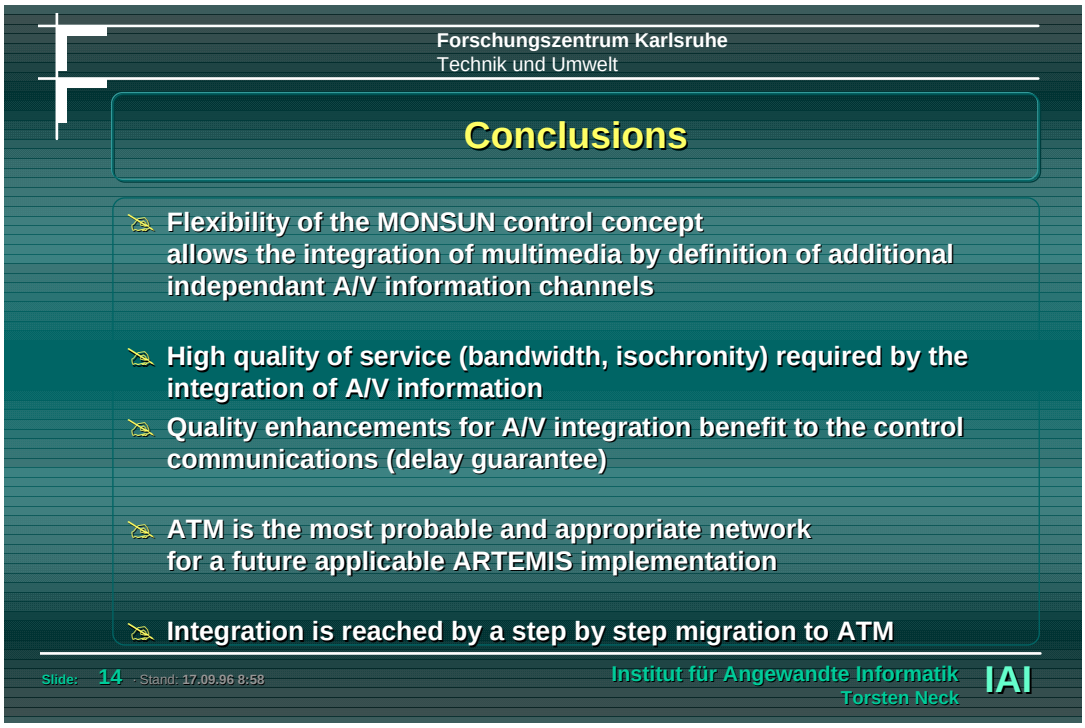




[Slide 13] And finally: our next step will be the **total elimination of edge devices** and the **only use of ATM** - so called **NATIVE ATM** - for all the transport, thus **reducing the complexity**.

And – as you can see in comparision to the initial solution – we will have the **same complexity** but with a **changed TOPOLOGY: no more bus** or **shared medium, but dedicated lines with a single dedicated, parameter controlled protocol**.

May we have the last slides please.



[Slides 14 and 15] You can read my conclusions on the left slide. If you have further questions feel free to contact me with the address and numbers presented on the right slide. Thank you very much for your attention.