Open Modular Systems –
Ready-to-run for Customized Projects

3G Networks will benefit most

By Dr. Stephan Rupp, Claudia Bestler, Kontron

AdvancedTCA and MicroTCA claim to provide standardised COTS components for cost effective system designs with short lead times and high flexibility. At the same time, the technology is new to many systems designers and in practice, a high degree of customization is indispensable. In order to speed up systems design and to shorten project lead times, Kontron offers Open Modular Platforms. The systems are designed to the typical class of application and are available as pre-configured and validated systems. They allow further customization for AdvancedTCA and MicroTCA systems from entry level and compact designs to the highest capacity. Kontron Open Modular Solutions thus provide both building blocks and ready-to-run systems for a professional and successful implementation of projects.

Design to Class – Many Applications, few Application Profiles

AdvancedTCA and MicroTCA apply to many areas. In telecommunications, typical applications include Call Servers, Gateway Controllers, IMS-CSCF, HLR/HSS, Media Gateways, Trunking and Signalling Gateways, Media Servers and Proxies for IPTV and Content Adaptation, Radio Network Controllers (RNC), Tetra and P25 Switches, WiMAX Access Controllers, Base Stations for 2G, 3G and WiMAX, as well as IP-PBX servers. Related applications in the Military segment include radar, image processing and communications. In the Medical segment it applies to image processing. With the venue of industrial Ethernet as follower to today’s field bus systems, AdvancedTCA and MiicroTCA allows to implement process control, facility control, and communications. In Transport, it may support infotainment, announcements, and video surveillance.

With AMCs as common components, all of those applications can be designed with both AdvancedTCA and MicroTCA. The size of the system makes the difference. As a rule of thumb, AdvancedTCA applies, if more than 20 AMCs are needed. For less than 20 AMCs, both AdvancedTCA and MicroTCA apply.

A comparison of designs for a sample of applications shows, that the designs tend to be similar, due to similar requirements in different applications. Applications with similar requirements or similar profiles can be considered on a higher level of abstraction as different classes of applications. Designing a system to a class of applications allows covering all essential requirements by a standardized system. The implementation of further requirements then represents a customization of this design. Kontron Open Modular Platforms are ready-to-run systems designed to a class of applications. Choosing the right Open Modular Platform may significantly reduce project lead times and considerably facilitate the introduction of AdvancedTCA and MicroTCA technology.
From Application Profiles to Systems Design

The applications mentioned in the beginning may be grouped into three different classes with similar application profiles: Session Processing (e.g. Call Servers, IMS, SIP-Servers), Media Processing (e.g. IPTV, content adaptation and content filtering), and Gateways (such as Media Gateways, Trunking Gateways, RNCs, Tetra-Switches or P25-Switches) have different requirements on the system.

When designing to the class, each Application Profiles corresponds to a typical Systems Architecture. The systems may differ in terms of capacity, but their architecture is similar for each area of application. The design also needs to reflect the non-functional requirements such as the redundancy needed in order to provide systems with outstanding availability. The Systems Architecture then translates into the specific designs with AdvancedTCA and MicroTCA.

The designs are compatible with enterprise IT based designs and support mainstream Linux OS releases and open source developments. However, Advanced TCA has the advantage of providing access to a professional class of carrier grade hardware technology. In comparison to other technologies, AdvancedTCA provides the highest density of computing and the most compact designs at minimum floor space, minimum cabling and power consumption.

Session Processing

Session Processing covers the following areas of application:

- Transaction processing with high performance, low latency and high availability
- Call Servers, Media Gateway Controllers, SIP-Servers, IMS-SCSF, HLR/HSS
- Process control, facility control, monitoring and control of distributed systems

The controlling device in Next Generation Networks is a session processor. Figure 1 shows the typical scenario. The Session processor is located in the IP-domain of the Next Generation Networks. It controls call sessions or multimedia sessions of users within this IP domain, but also sessions originating or terminating in the traditional public telephone networks (PSTN) or mobile networks (PLMN). The Session Processor is a transaction processor for mass transactions with low latency and with high systems availability (99,999% or maximum 5 minutes outage per year).

![Session Processing Application](image-url)

Figure 1: Session Processing Application

There are many other related applications with such a profile, such as in industry automation and control. In telecommunication networks, the typical protocol to handle communication sessions is SIP, the Session Initiation Protocol. Session processing may be separated into different tasks (1) the processing of the protocol, (2) the processing of the session state and subscriber profile at abstract level.
The functional requirements may be summarized in the following way:

- Handling of many call sessions (application) and protocols
- Control traffic only (no user traffic or media streams)
- Two-tier architecture with protocol engines and application engines
- Data base completely in RAM (e.g. SQL cluster).

In order to cover requirements on high-availability, the architecture is not allowed to not contain a single point of failure, so it needs:

- Controllers and Hubs 2x redundant
- Call processors and protocol processors N+1 redundant
- Carrier grade availability (components hot-swappable, redundant configurations).

Those requirements are reflected in the systems architecture shown in Figure 2. The processing of the session protocol is handled by Protocol Engines, the higher layer session processing is handled by Application Engines. A third kind of processing element are the Main Controllers, or system controllers, who are responsible to keep the system running and keep track of processes and operation.

But how many processing elements are needed? This certainly depends on the performance of the processor elements for the given kind of transactions. The number of transactions required follow from the traffic profile, e.g. 1 Mio of subscribers with 3.6 calls in the busy hour (i.e. 3600 seconds) will result in 1000 call transactions per second. The numbers of messages to be handled per transaction follows the sequence of call set-up and tear down using the session protocol. For such scenarios, lab benchmarks or published benchmarks may be used to determine the number of processors needed. The traffic throughput of a session processor is comparatively low: at 4 SIP messages in and out per call transaction at 8 kbits per message, the total traffic just represents 32 Mbps.

Another important guideline for the systems design is the redundancy concept. For the given system architecture, it is assumed that the Main Controller is 2x1 redundant, i.e. there are 2 Main Controllers in the system e.g. in active/standby configuration. The number of Application Engines and Protocol Engines is assumed to be N+1 redundant, i.e. there is one extra processing element and N elements are able to handle 100% of the load. Concerning the network interfaces, ATCA facilitates the design by suggesting 2x1 redundant hubs with dual star connection to each of the processing elements over the Basic Interface. Figure 3 shows a corresponding system design in ATCA.
The system design directly reflects the systems architecture shown in Figure 2 before. The main controllers are located as AMCs on the hub and thus support the 2x1 redundant concept in the most obvious way. In the small configuration shown in the figure, there are 2 Call Engines and 2 Protocol Engines. In this case, the N+1 redundancy is identical with 2x1. For larger systems, such as in a 14-slot chassis, both Application Engines and Protocol Engines may be N+1 redundant with a better economy of processors. The Application Engines are configured as server blades with AMC disks directly on the processor board. This simple allocation of disks facilitates the systems operation, i.e. the replacement of processor elements in the field. A small redundant system contains 4 x CPUs blades, 2 x Hub blades, 2 x CPU AMCs and 8 x Storage AMCs.

Media Processing

Media Processing covers the following areas of application:

- High throughput media processing
- IPTV over wireline and wireless networks, Content Adaptation, Content Filtering, Voice-Quality-Enhancement, Media Servers & Proxies
- Radar, Image Processing, Video Surveillance, Infotainment

The processing of IP Media comprises the provision of IPTV media streams over 3G mobile networks, CableTV networks or DSL networks, as shown in Figure 4. In the same way, Media Servers may act as sources of IP Media or Proxies of IP media servers with processing for content adaptation or content filtering in order to improve the quality of media streams including VoIP over the specific user session.
A Media Server of this kind represents an engine for high-throughput media processing. In comparison with Session processing, it has to process a significant amount of user traffic. A typical traffic model may include media streams of 128 kbps per session (over 3G networks or WiMAX networks), or 2 Mbps (over CableTV or DSL networks). With 200,000 subscribers, 1 session per subscriber in the busy hour, and 3 minutes session length, the system will need to handle 5000 parallel sessions. This results in 640 Mbps of total traffic (for 3G and WiMAX networks), respectively 10 Gbps of total traffic (over CableTV and DSL).

The functional requirements may be summarized in the following way:

- Processing of sessions (voice/data) & media streams (many Mbps)
- Content Adaptation and media conversion supported by DSPs
- Streaming media on disk (Server or Proxy) with Buffer in RAM

In order to cover requirements on high-availability, the architecture is not allowed to not contain a single point of failure:

- Controllers and Hubs 2x redundant
- Application processors N+1 redundant
- Carrier grade availability (components hot-swappable, redundant configurations)
- High fabric capacity (independend and redundant fabrics).

This profile corresponds to the systems architecture indicated in Figure 5. The number of processing elements depends on the individual performance of the components chosen. Indications can be derived from own lab benchmarks and published benchmarks.

Figure 5: Media Server Systems Architecture

The application Engines are responsible for the provision and filtering of media content. Depending on the individual needs, the may be further specialised. One particular requirement are high continuous data rates at the disk subsystems. The Application Engines may be provided in an N+1 redundant way. The system also contains 2x1 redundant Main Controllers, and 2x1 redundant uplinks at the hubs. One option is the use of DSPs to support the processing of media, such as for transcoding into different data rates or improvement of quality. For this case, the system contains Media Engines consisting of DSPs and control CPUs.

The systems architecture easily translates into an ATCA design, as shown in Figure 6. Again, the Main Controllers are located on the hubs. To handle high traffic capacities, the hubs may be customized with 2x10GbE Fabric uplinks for traffic distribution and interconnection with other systems. The Application Engines are represented as processor blades including AMC disks. The Media Engines are implemented on a carrier blade with 1 to 3 DSP farms on AMC and one processor AMC. The shown configuration has 2 Application Engines and 2 Media Engines on carriers in redundant configuration. A small redundant system contains 2 x CPUs blades, 2 x Hub blades, 2x Carrier Blades, 4 x CPU AMCs, 2x to 6x DSP AMCs and 4 x Storage AMCs.

Options to extend the storage capacity are more HDD on RTMs for the CPU blades, as well as external SAS JBODs or SAS RAIDs, which also connect to the RTM of the CPU blades. Of course, the system also
supports Fibre Channel or iSCSI based external storage. Among the further options for customization are 2x 10 GbE uplink modules on AMCs to extend the uplink capacity of the Hub blades.

![Figure 6: Systems Design in ATCA – Media Processor](image)

As Figure 6 shows, the usage of the AMC form factor provides extremely compact designs and the highest density of processing. In a larger housing, such as a 14-slot chassis, the architecture remains the same, but provides extra room for extensions with more Application Engines and Media Engines (in N+1 redundancy). The capacity may be further extended by interconnecting multiple chassis. This way, even when starting from a compact system, the capacity may increase according to demand, i.e. with growing numbers of subscribers and growing traffic.

**Gateways**

Gateways cover the following areas of application:

- TDM to IP conversion at application layer (control and media traffic)
- RNC (Radio Network Controller), Tetra/P25 Switches, Trunking Gateways, Media Gateways
- Infotainment, Video Surveillance, Videoconferences, Communication Systems

Gateways are typically used to interconnect systems with TDM interfaces and systems with IP interfaces. Among the typical areas of application are 2G or 3G base stations to 3G radio Network Controllers, Tetra or P25 base stations to Tetra-Switches or P25 switches, or IP network domains to traditional telephone networks (PSTN) or cellular mobile networks (PLMN). Figure 9 shows a summary.

![Figure 7: Gateway Application](image)
By definition, a Gateway between TDM and IP needs to convert TDM control messages and data streams to IP control messages and data streams. A Gateway thus essentially represents a TDM to IP converter with processing at application layer (i.e. termination of protocols in each domain and translation into each other). Also by definition, a Gateway will need to support special interfaces within the TDM domain, such as 2 Mbps lines over E1 (respectively T1), or higher traffic capacities over STM-1/OC3 (155 Mbps) or STM-4/OC12 (622 Mbps).

The functional requirements may be summarized in the following way:
- Processing of sessions (application), media streams and protocols
- Conversion of control traffic and user traffic between TDM and IP (supported by DSPs)
- I/O subsystem with TDM interfaces and protocols

In order to cover requirements on high-availability, the architecture is not allowed to not contain a single point of failure:
- Controllers and Hubs 2x redundant
- Application processors N+1 redundant
- Independent and redundant networks for base and fabric in backplane

As shown in Figure 10, the basic functional elements of Gateway are the Protocol Engines, which process the higher protocol layers in cooperation with interface cards (for the lower protocol layers), Application Engines to terminate and translate sessions in each domain, and Media Engines including DSPs to support the trans-coding of TDM and IP streams. Again, the system contains Main Controllers for operation. The quantity of components which are needed again can be derived from a corresponding traffic model and the performance of the chosen components. The systems architecture translates into an ATCA systems design as shown in Figure 11.

Application Engines again are represented as ATCA blades with disks on AMCs. The Main Controllers (not indicated in Figure 11) may be placed on the hubs. The design makes best use of AMCs on carriers and thus provides a compact design with highest density of processors: both the Media Engines and the Protocol Engines are implemented on carrier boards with DSPs on AMC and TDM interfaces on AMC.
Options for customization include the usage of more DSPs or more TDM interfaces, depending on the amount of traffic and the types of interfaces needed. Depending on the number of sessions to be processed, session set-up and tear down could also be controlled by the CPU blade (Application Engine), rather than by the PrAMC on the carrier. As an alternative to interfaces and DSPs on the carrier, both AMCs could also be allocated on the CPU blade. Such a design would then allow the usage of 4 CPU blades in a compact system. The variety of Gateway type of applications is large. Ultimately, the specific application software will determine the optimum design. In any case, the design shown in Figure 9 provides an entry level solution with a high degree of flexibility.

**Kontron Open Modular Platforms (OMP)**

**Session OMP**

The Session OMP is designed to the Session Profile, i.e. it is targeted at applications with high demands on processing of transactions at low latency and with the highest degree of availability. The systems architecture supports two redundant hubs and two redundant main controllers. Protocol engines and application engines may be operated as multiprocessor systems in 2x redundant or N+1 redundant configuration. The Session OMP Standard Configuration contains two ATCA processor blades and two processor AMCs as main controllers, but allows more processor blades or processor AMCs to be added.
As shown in Figure 10, the Session OMP Standard Configuration is based on a 5U 6-Slot ATCA Chassis incl. Shelf Manager and Systems Alarm Panel and contains 2x ATCA Hubs, 2x ATCA processor blades with SATA HDD, 2x processor AMC, Linux 2.6 and is delivered fully integrated, configured and tested. All components are hot swappable and the platform provides a high degree of management due to out of band shelf management. High availability may be further supported at OS level by mainstream Linux clusters, as well as by professional middleware to support HA.

**Media OMP**

The Media OMP is designed for the Media Profile, i.e. it is targeted at applications with high demands on processing of IP based media and with the highest degree of availability. The systems architecture supports two redundant hubs and two redundant main controllers. Media processing engines and application engines may be operated as multiprocessor systems in 2x redundant or N+1 redundant configuration. The media processing engines comprise signal processor AMCs and processor AMCs as controllers on an ATCA carrier blade. The Media OMP Standard Configuration contains two ATCA processor blades, two processor AMCs as main controllers, and two carriers with one processor AMC and one DSP AMC each. It allows more AMCs to be added, e.g. 10 GbE uplinks on the ACTA hub, more DSPs or TDM interfaces.

As shown in Figure 10, the Media OMP Standard Configuration is based on a 5U 6-Slot ATCA Chassis incl. Shelf Manager and Systems Alarm Panel and contains 2x ATCA Hubs, 2x ATCA processor blades with SATA HDD, 2x processor AMC. So far, the configuration corresponds to the Session OMP. In addition, the Media OMP has 2x ATCA carrier blades, 2x processor AMCs and 2x DSP AMCs. It is delivered incl. Linux 2.6 fully integrated, configured and tested. All components are hot swappable and the platform provides a high degree of management due to out of band shelf management. High availability may be further supported at OS level by mainstream Linux clusters, as well as by professional middleware to support HA.

Of particular importance for media processing is the fabric capacity and the separation of networks in the backplane. Figure 12 shows the capacity of base and fabric networks for the standard configuration. Each ATCA board connects to both hubs over the base interface. On the fabric, each hub supports two separate fabric networks to each ATCA board. The hubs represent managed switches and support separation of networks by protected port groups and VLANs. The standard configuration supports 4x GbE uplinks for base and fabric on each hub. Due to the modular architecture of the hub, both fabric uplinks and fabric backplane capacity may be upgraded to 10 GbE as customization.
Options for customization:

- More DSPs on AMC
- HDD on RTM for CPU Blades
- External SAS or SATA storage (SAS JBOD, SAS RAID) over RTM for CPU Blades
- Fibre Channel or iSCSI based external storage
- 2x 10 GbE Uplinks on Hub
- TDM interfaces on AMC
- 14 Slot Chassis (13 U)
- Migration to 10GbE Fabric in Backplane

**Gateway OMP**

The Gateway OMP is designed for the Gateway profile, i.e. it is targeted at applications which need to convert control traffic and media traffic between TDM based networks and IP networks with the highest degree of availability. The systems architecture supports two redundant hubs and two redundant main controllers. Media processors, application engines and protocol engines may be operated as multiprocessor systems in 2x redundant or N+1 redundant configuration.

The media processing engines comprise signal processor AMCs and processor AMCs as controllers on an AdvancedTCA carrier blade. TDM interfaces are also provided as AMCs on an ATCA carrier together with processor AMCs to process the higher protocol layers. The Gateway OMP Standard Configuration contains two ATCA processor blades, two processor AMCs as main controllers, and two carriers with one processor AMC, one DSP AMC and one TDM interface AMC each. It allows more AMCs to be added, e.g. more DSPs, more TDM interfaces, or different TDM interfaces.
As shown in Figure 13, the Gateway OMP Standard Configuration is based on a 5U 6-Slot ATCA Chassis incl. Shelf Manager and Systems Alarm Panel and contains 2x ATCA Hubs, 2x ATCA processor blades with SATA HDD, 2x processor AMC, 2x ATCA carrier blades, 2x processor AMCs, 2x DSP AMCs. So far, the configuration corresponds to the Media OMP. In addition, the Gateway OMP contains 2x TDM AMCs with 8x E1/T1. The system is delivered incl. Linux 2.6, fully integrated, configured and tested. All components are hot swappable and the platform provides a high degree of management due to out of band shelf management. High availability may be further supported at OS level by mainstream Linux clusters, as well as by professional middleware to support HA.

Options for customization:
- More TDM interfaces on AMC (E1/T1)
- Higher density TDM interfaces: STM-1/OC3 or STM-4/OC12.
- More DSPs on AMC
- DSP AMC and TDM interface AMC on CPU Blades (instead of Carrier)
- HDD on RTM for CPU Blades
- External Storage for CPU Blades over RTM (SAS JBOD, SAS RAID)
- 14 Slot Chassis (13U)

**MicroTCA Multiprocessor System**

The Multiprocessor System is targeted to applications with extensive use of Ethernet capacity or multiple networks in the backplane, but limited number of processors and a compact form factor, which can be designed by AMCs in a MicroTCA environment. The typical areas of application demand high processing power at low latency, such as entry-level systems for telecommunications, facility control, process control, image processing, wire-speed media processing, or video surveillance.

For the sake of high availability, the systems support redundant architectures. The Multiprocessor system is available in a 19” MicroTCA chassis dual star fabric for redundant hubs (MCH), incl. power supplies, power feed through modules and cabling. The backplane provides a dual star GbE fabric, PCIe lanes to both MCHs, and point-to-point connections for SAS/SATA. With processors and dual core technologies available on AMC, it supports high performance processing. The chassis allows to accommodate 10 full-size AMCs, or 8 full-size AMCs and 4 Half-Size AMCs.

![Dual Star Backplane](image)

*Figure 14 – MicroTCA Multiprocessor System*

The standard configuration contains 2x PrAMCs, 2x HDD on AMC and two MCH in redundant configuration to provide Ethernet connectivity on the backplane for 12 AMCs each, as well as front panel uplinks for the system. Each MCH can also provide PCIe connectivity for 12 AMCs. Options for extension include TDM interfaces on AMC, DSPs on AMC, dual core PrAMCs, as well as non-redundant configurations with only one MCH.
Options for customization:
• TDM Interfaces (e.g. Quad or 8x E1/T1)
• DSP AMC modules for media processing
• Dual Core Processor AMC modules
• Non-redundant configuration with single MCH

MicroTCA Compact System

The Compact system targets Industrial PC type of applications without need for redundancy and is well suited for entry level systems with AMCs. It is available in a 5 slot chassis with single star fabric, incl. AC power and fans. The chassis allows to accommodates one standard MCHs and 4x AMCs. The backplane supports GbE fabric to all slots, PCIe fabric to all slots (via the MCH) and point-to-point connections for SAS/SATA.

The systems supports multiple processors connected over GbE on the backplane, as well as combinations of PrAMCs with AMCs for peripherals, which connect over PCIe with the PrAMC. The standard configuration contains one MCH incl. GbE and PCIe connectivity to all slots, 1x PrAMC and one HDD on AMC. The system is delivered incl. Linux 2.6, integrated, configured and tested.

Options for customization:
• Dual Core Processor AMC
• Multiple Processor AMCs
• DSPs on AMC
• Interface modules on AMC

A Comprehensive Portfolio

Being among the pioneers of ATCA and active at PICMG, CP- TA and SCOPE, Kontron provides a comprehensive portfolio of AdvancedTCA, AdvancedMC and MicroTCA platforms. The products include the latest in processing technology on AdvancedTCA processor blades and processor AdvancedMCs, AdvancedTCA Base and Fabric switches for 1GbE and 10GbE switches, AdvancedTCA carriers and an extensive range of AdvancedMCs modules. Pursuing its concept of “AMC Everywhere”, Kontron supports the most compact and highest density of systems designs.
Kontron Open Modular Solutions support systems design with AdvancedTCA and MicroTCA in the most effective way: Open Modular Platforms provide ready-to-run systems, which are designed to the right class of application and allow to speed-up systems design and project implementation significantly. Kontron’s professional building blocks allow further customization of the systems tailored to the individual demands. Building on proven designs and validated systems offers a substantial advantage for a successful project. Open Modular Solutions provide leading edge technology from entry level and compact designs up to the highest capacities in the most professional and efficient way.

References:

[1] Traffic Model for IPTV over DSL, CaTV and 3G/WiMAX (Spreadsheet, XLS):