

Real-time communication

RT-SDC in the OR of the future

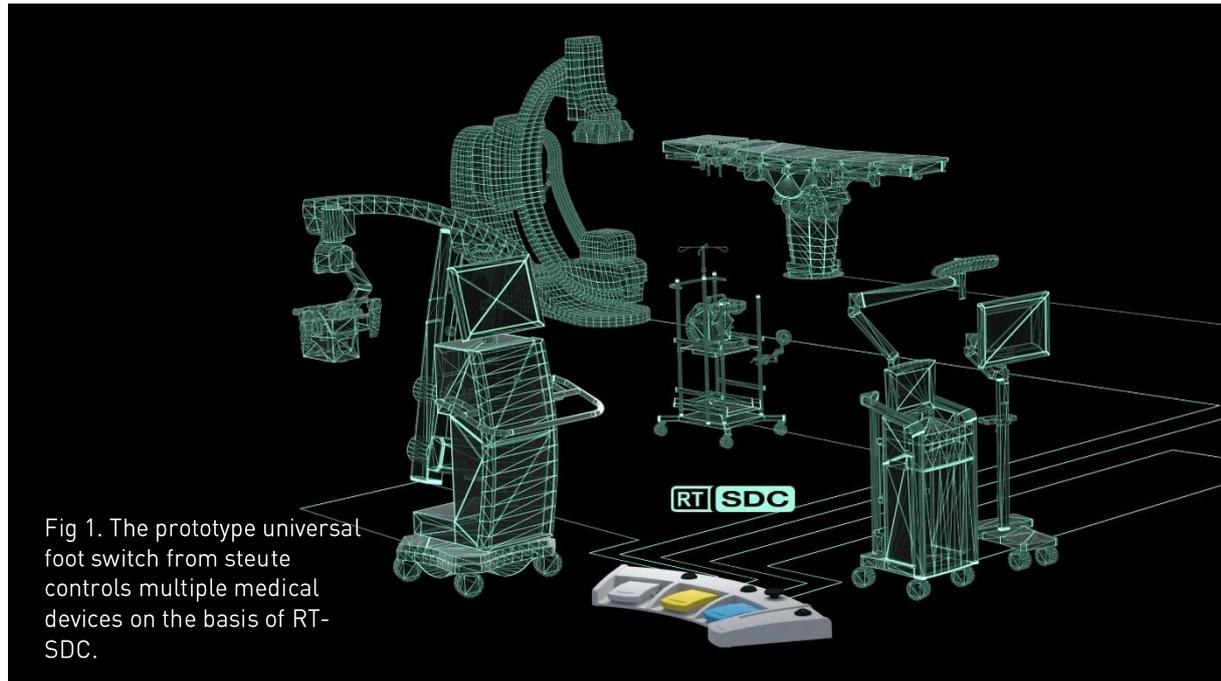


Fig 1. The prototype universal foot switch from steute controls multiple medical devices on the basis of RT-SDC.

For increased efficiency, flexibility and safety: Real-Time SDC (Service-oriented Device Connectivity, RT-SDC) expands the IEEE-11073-SDC family of standards to include real-time capability. Communication between medical devices and their controls becomes deterministic, reliable and interoperable.

In state-of-the-art operating rooms, medical devices are usually only integrated as siloed solutions. Device manufacturers often favour proprietary interfaces, impeding smooth integration in complex, cross-manufacturer OR environments. The IEEE-11073-SDC family of standards is now addressing this problem by defining appropriate communication protocols and a data model.

The OR of the future will be modular: one or more central/peripheral user interface(s), such as control units or foot switches, will control multiple devices from different manufacturers – ranging from surgical tools to navigation systems to imaging techniques. The benefits are obvious: less switching between controls, more efficient device operation, shorter surgeries, reduced risk of error, and increased patient safety.



Fig 2. Digital data flow between medical devices facilitates new applications: for example, a device with closed-loop control can request the necessary measurements from other participants within the network. The medical devices in the OR can be operated via a central user interface.

Basis for interoperability

The SDC family of standards enables cross-manufacturer communication between medical devices. Core aspects:

- Device Profile for Web Services (DPWS) as the communication protocol
- Possibility to use other communication protocols
- Medical Device Information Base (MDIB) as self-description of medical device functionality
- Plug-and-play or plug-and-trust for medical devices
- Safeguarding of device communication through state-of-the-art encryption methods and certificates

This development began with the flagship OR.NET research project, funded across Germany by the BMBF (2012–2016), as well as diverse previous projects. Since then, the family of standards has been continually expanded.

Limitations of SDC

Classic SDC uses standard Ethernet. This achieves reliability and interoperability, but not, however, guaranteed latency or deterministic transmission. In time-critical applications, and depending on the use

case, problems can arise such as the foot switches and medical devices having to switch off reliably and set new target values within milliseconds.

Time-critical closed-loop controls require constant cycle times. Navigation and imaging require synchronised, high-frequency data streams. Proprietary protocols provide low latency, yet impede smooth, cross-manufacturer integration.

The solution is expansion of SDC to include real-time capability: RT-SDC.

WHAT IS OR.NET E.V.?

OR.NET e.V. emerged from the BMBF-funded flagship OR.NET project (2012–2016 with over 50 project partners). Its goal was to drive forward the safe, dynamic integration of medical products in the OR and hospitals.

The Association promotes open, cross-manufacturer integration of medical devices in the OR, intensive care and other acute care units. Its focus is on safe device-to-device data exchange via plug-and-play.

OR.NET unites industry, hospitals and research. Its methods of support include standardisation, demo and test centres, as well as consulting for SDC interface development, approval and realisation. www.ornet.org



Fig 3. The majority of user interfaces produced by steute Meditec now communicate with their corresponding medical devices remotely.

RT-SDC for real-time applications

RT-SDC constitutes an expansion of the IEEE-11073-SDC family of standards to include deterministic communication capability. The goal is not to replace the existing SDC standard, but rather to complement it and unite both approaches in a coexistence architecture: while SDC guarantees reliable, non-time-critical communication between medical devices, RT-SDC assumes time-critical control tasks and enables precisely synchronised processes.

Realisation of real-time capability is based on three key technologies:

- Time-Sensitive Networking (TSN) to IEEE 802.1Q, ensuring guaranteed latency, bandwidth reservation and prioritisation of safety-critical data streams
- Precision Time Protocol (PTP) to IEEE 1588, enabling highly precise, sub-microsecond time synchronisation
- Data Distribution Service/Real-Time Publish Subscribe (DDS/RTPS), providing performant user-level data exchange based on publish/subscribe principles.

Technical realisation

Time-Sensitive Networking

TSN is a further development of Ethernet which enables reliable and precisely timed data transmission. For use in the OR, this means that crucial control information is prioritised and transmitted with complete timing accuracy.

It is also possible to determine which data streams will always have sufficient bandwidth and be transmitted steadily and predictably.

This guarantees that devices in the OR can work smoothly and in perfect harmony. The network can be automatically configured on the basis of device self-description in SDC/RT-SDC.

Precision Time Protocol

The Precision Time Protocol (PTP) permits synchronisation of device clocks to the sub-microsecond. In the OR, this enables the precise and simultaneous actuation of multiple devices, alleviating coordination of

SHORT AND TO THE POINT: SDC AND RT-SDC

SDC: IEEE 11073 Service-oriented Device Connectivity

- Family of standards for cross-manufacturer integration of medical devices in the OR and hospitals
- Service-oriented architecture
- Self-description of devices (MDIB)

RT-SDC: expansion to realise use cases requiring real-time capability measured in milliseconds

- Combination of DDS/RTPS and TSN or QoS

complex processes. In addition, PTP guarantees exact clocking of all relevant events, which is essential for both regulatory requirements and uninterrupted traceability.

Data Distribution Service / Real-Time Publish Subscribe

DDS/RTPS is based on a publish/subscribe architecture which enables a fine granular configuration of quality-of-service parameters. In the context of RT-SDC, DDS is used in conjunction with the Real-Time Publish-Subscribe (RTPS) protocol in order to realise hard real-time requirements. Benefits include flexible adaptation to different bandwidth and latency requirements, automatic detection of new devices and services, as well as optional parallel operation alongside existing SDC implementations.

RT-SDC in practice

- **Wireless foot switches:** With RT-SDC, a single wireless foot switch can control multiple devices from different manufacturers in parallel. One example: a high-frequency surgical device and a navigation system are controlled simultaneously. Deterministic communication ensures that commands arrive with precise predictability – even when network traffic is high.
- **Universal hand-held remote control:** A hand-held remote control can be configured dynamically to control different devices depending on the phase of surgery. Changes are made during the intervention, without delay or manual switching.
- **Closed-loop control:** In the future, on the basis of RT-SDC, diverse interoperable closed-loop controls will be

implemented, for example between a ventilation device and a C-arm in order to briefly stop ventilation and create an image. Other possibilities include neurostimulation, ventilation and medication administration, e.g. to regulate blood pressure.

Benefits for manufacturers

From the standpoint of medical device manufacturers, RT-SDC has many different strategic and technical benefits. Consistent promotion of interoperability means that devices can be seamlessly integrated in open, cross-manufacturer OR architectures. This not only opens up new chances in the market, but also makes it easier to collaborate with clinics and hospitals favouring modular and flexible system solutions.

Another crucial aspect is safety: guaranteed latency periods in communication increase functional safety and

AT A GLANCE: STEUTE TECHNOLOGIES

In its »Meditec« division, steute has specialised in the development and production of user interfaces for medical devices, for example foot switches and hand controls. These ergonomic and intuitive interfaces, which can be cabled or wireless, are designed for OEMs specifically for their individual medical applications in surgery, medical imaging, ophthalmology or dentistry. steute Meditec has a wealth of expertise regarding wireless technologies and standards: with more than 20 years of experience in wireless systems, the medical device supplier meets strict standards such as IEC 60601 and operates to ISO 13485 – including MDR and FDA compatibility. www.steute-meditec.com

enable precise and reliable execution of time-critical commands – a factor which in surgical applications is particularly relevant.

Moreover, RT-SDC contributes to cutting costs by lowering the need for proprietary interfaces and significantly reducing integration effort for new devices. Adherence to internationally recognised standards also supports manufacturers with their regulatory affairs since many requirements found in existing regulations are already fulfilled. Alignment with future-proof IEEE standards also protects investments: devices equipped with RT-SDC today are prepared for upcoming developments in OR integration and will remain compatible with future extensions to the family of standards in the long term.

Inside the OR of the future

RT-SDC is the next logical step in the development of interoperable OR technologies. It links the semantic strength

of SDC with the deterministic precision of TSN, PTP and DDS/RTPS. For manufacturers this means: higher product compatibility, lower integration costs and the possibility to realise innovative use cases. Integration in international standards such as IEEE and/or IHE-Profile is safe – manufacturers who opt for RT-SDC early on secure themselves a competitive advantage. In the long term, RT-SDC will not only make surgical interventions safer and more efficient, but also open up new application fields, such as AR-based navigation or AI-based assistance systems.

Authors:



Marcus Köny
Senior Project Manager Connected Systems
steute Technologies



Julia Mönks
Product Manager Meditec
steute Technologies

Images: steute Technologies GmbH & Co. KG / Image 2: Adobe Stock