ALBERTA INNOVATES

Applied Digital & Emerging Technologies

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Communications networks and services	**Communications networks and services** are evolving to support scalable, secure, and agile connectivity across diverse applications like IoT, cloud computing, and 5G. Software-defined networks and virtualized functions enable dynamic orchestration and efficient resource use across heterogeneous wired, wireless, and satellite systems. These innovations ensure high performance, energy efficiency, and seamless interoperability for real-time, bandwidth-intensive services.
Internet of Things (IoT) / Machine-to-machine systems	**Internet of Things (IoT)/Machine-to-machine systems** refer to interconnected, low-power, software-enabled devices that communicate autonomously across various environments - stationary, wearable, and mobile. These systems operate in real or near-real time, integrating vast and diverse sensor data to support timely, reliable decision-making. Scalable IoT infrastructure relies on robust architectures and standards to ensure secure data fusion, authentication, and efficient information delivery across dynamic networks.
Advanced data management and analytics	**Advanced data management and analytics** involve new methods for handling vast, diverse, and fast-moving data to enable real-time prediction, optimization, and anonymization. These systems extract meaningful insights from various sources - text, images, video, audio, and social data - to support accurate, timely decision-making through interactive tools and visualizations. Artificial intelligence and machine learning play a key role in scaling these capabilities across sectors for digital transformation.
Cybersecurity	**Cybersecurity** involves scalable, effective methods for authenticating identities and authorizing access to protect data and systems from evolving threats. It uses quantitative models, analytics, and standards to detect and prevent attacks - including those driven by IoT, personal informatics, and quantum computing. Advanced threat detection systems coordinate across time and data sources to defend against complex, stealthy, and adaptive cyber threats.
Human interaction with digital media	**Human interaction with digital media** focuses on designing seamless, engaging, and cognitively accessible experiences through invisible interfaces, gamification, and clear data representation. It supports diverse users and contexts - such as wearables, augmented reality, and personal data spaces - by enabling effortless interaction and meaningful feedback. Advanced design tools empower users of all skill levels to create, customize, and collaborate across physical and virtual environments with minimal training
Quantum computing	**Quantum computing** harnesses quantum engineering to develop devices and applications - using qubits, entanglement, and quantum algorithms - that outperform classical systems in sensing, communication, and information processing. These technologies have near-term potential in

	fields like medicine, environmental monitoring, and secure communications. The development of special-purpose quantum processors and algorithms is key to advancing quantum simulations, error correction, and broader digital transformation.
Automation (including robotics)	**Automation (including robotics)** focuses on designing intelligent, modular, and reconfigurable machines that enhance productivity, accuracy, and safety in sectors like manufacturing, transportation, and agriculture. It integrates smart sensors, actuators, and control systems with digital models to optimize machine performance and human-machine interaction. These systems enable adaptive, energy-efficient operations through predictive planning, real-time feedback, and environmentally friendly processes.
Lightweight materials and technologies	**Lightweight materials and technologies** focus on developing innovative, multi-material designs and manufacturing methods that deliver high performance and energy efficiency throughout a product's lifecycle. Using integrated computational materials engineering (ICME), these approaches optimize structure, process, and property relationships to accelerate product development. Projects also address system-level integration challenges to ensure seamless assembly and use across industries.
Additive manufacturing	**Additive manufacturing** refers to advanced production methods that build parts layer by layer, integrating real-time monitoring, sensing, and closed-loop control to enhance speed, consistency, and quality. It involves the development of tailored, printable materials that improve deposition, sustainability, and post-processing performance. Computational design approaches link process characteristics to part functionality and geometry, unlocking the full potential of additive manufacturing technologies.
Nanotechnology	**Nanotechnology** involves the design and synthesis of materials at the nanoscale, where unique structural and functional properties enable the creation of advanced 3D hierarchical systems. It focuses on Earth-friendly nanomaterials like graphene, quantum dots, and polymer nanocomposites, supported by science-based modelling for integration into products. Scalable, clean manufacturing techniques are essential for producing high-quality nanomaterials efficiently and safely for widespread industrial use.
Quantum materials	**Quantum materials** are advanced substances like graphene and other two-dimensional crystals that exhibit exceptional mechanical, electronic, and thermal properties. Research focuses on scalable manufacturing of these materials and their integration into devices such as sensors, batteries, flexible electronics, and optoelectronics. Their unique characteristics enable transformative applications in nanoelectronics, energy systems, and next-generation computing.