The current evolution of CT is driven by cardiac imaging. Reliable and robust diagnostic performance for this application is crucially dependent on temporal resolution. Very different approaches are taken by the major vendors. Rotational time is unanimously accelerated and has currently arrived at 270 msec per rotation, but today’s scanners barely meet the requirement of 65 msec per image at higher heart rates.

Another industry focus relates to the detector with more and more rows added. A complete cardiac dataset can nowadays be acquired in less than 6 sec with detector sizes > 8 cm in z-direction. This renders the method less susceptible to arrhythmia and heart rate variations. The best, currently available, solution operates at a detector size of 16 cm covering the heart at a single rotation, albeit compromising on temporal resolution.

The technical evolution has also realized that dose exposure needs to be decreased substantially for a widespread application. This has culminated in a trend away from spiral acquisitions to prospective axial rotations. This allows to reduce dose exposure by as much as 80%.

Provided that the current speed of technical improvements will persist it is foreseeable that most invasive angiograms will be replaced in the upcoming years. CT equipped with future detector technology has the potential to become the prime imaging modality for cardiovascular medicine.
The state of the art of CT is constantly improving. Today, new scanner generations with improved technology are being introduced every 1–2 years, a pace that is foreseeably persisting, if not accelerating. The current driving force behind this rapid evolution of technology is CAD, the number one disease entity with the highest ranking incidence and mortality. CT-based coronary angiography has emerged as a reliable, noninvasive test to rule out CAD in symptomatic patients (De Feyter et al. 2007). The method is still associated with major limitations, but has been met with great enthusiasm, and its use worldwide is increasing rapidly. MDCT for noninvasive coronary angiography is appealing because it has the potential to replace invasive coronary angiography and could become a cornerstone diagnostic tool for clinical decision-making.

Before MDCT coronary angiography can become a reliable alternative to invasive coronary angiography, several problems must be resolved. The most important obstacle to the use of MDCT coronary angiography (MDCT-CA) is severe coronary calcification, which either prevents assessment of the integrity of the underlying coronary lumen or, because of its “blooming” effect, leads to overestimation of coronary stenosis severity. The same holds true for in-stent imaging with blooming artifacts even more pronounced around dense metallic structures such as stent struts.

In addition, the presence of arrhythmias or unstable sinus rhythm precludes the use of MDCT-CA, because the technique requires data to be obtained from the same phase of several cardiac cycles (6–10 heartbeats) for the reconstruction of coronary images. A third concern is the fact that MDCT-CA is associated with relatively high X-ray radiation exposure (15–20 mSv; Earls et al. 2008; Klass et al. 2008). Substantial reductions are mandatory before a widespread use can be safely advocated.

Finally, improvement in temporal resolution to less than 50 ms (currently 83–135 ms with newest CT scanners) to reduce motion artifacts is desirable, but extremely difficult to achieve because such an improvement requires peak tube output power not available with current technology.

The aforementioned shows that substantial further improvements are required before MDCT-CA may compete for the standard of reference in CAD imaging, replacing 2D coronary angiography based upon catheterization techniques. Correction of these limitations will require a substantial amount of time, effort, and technical innovation.

A prerequisite to understand the current evolution of technology designed for cardiac CT is the knowledge of its current limitations in lieu of the multifaceted possibilities. This chapter therefore focuses on four typical applications for cardiac CT: (1) initial diagnostic workup of suspected CAD (confined to a low to intermediate pretest likelihood group to rule out disease), (2) follow-up of patients after coronary artery bypass graft (CABG) procedures to assess graft patency, (3) valve imaging (a new application made possible by constantly improving temporal resolution), and (4) the strongholds of cardiac CT to visualize the proximal parts of the coronary tree to identify anomalies or other infrequent entities.